UL 2610

STANDARD FOR SAFETY

Commercial Premises Security Alarm Units and Systems

UL Standard for Safety for Commercial Premises Security Alarm Units and Systems, UL 2610

Second Edition, Dated April 7, 2021

Summary of Topics

This publish of ANSI/UL 2610 dated January 31, 2023 includes a clarification of UL standards which have been superseded by this Second Edition, UL 2610. No changes have been made to the technical content of this standard.

The following standards have been superseded by the Second Edition of this standard, UL 2610, Standard for Commercial Premises Security Alarm Units and Systems:

- ***Fifth Edition of UL 365, Standard for Police Station Connected Burglar Alarm Units and Systems;***
- ***Fifth Edition of UL 603, Standard for Power Supplies for Use with Burglar-Alarm Systems;***
- ***Twelfth Edition of UL 609, Standard for Local Burglar Alarm Units and Systems;***
- ***Eleventh Edition of UL 636, Standard for Holdup Alarm Units and Systems;***
- ***Sixth Edition of UL 1076, Standard for Proprietary Burglar Alarm Units and Systems;***
- ***Fourth Edition of UL 1610, Standard for Central-Station Burglar-Alarm Units; and***
- ***Fourth Edition of UL 1635, Standard for Digital Alarm Communicator System Units.***

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UL 2610

Standard for Commercial Premises Security Alarm Units and Systems

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This ANSI/UL Standard for Safety consists of the Second Edition including revisions through January 31, 2023.

The most recent designation of ANSI/UL 2610 as an American National Standard (ANSI) occurred on April 7, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 General

1.1.1 These requirements cover construction, performance, operation, and maintenance of:

a) Central station burglar alarm systems intended and specifically designated for burglary-protection use at mercantile and banking premises, mercantile safes and vaults, and bank safes and vaults;

b) Police station connected burglar alarm units and systems for use in mercantile premises, mercantile safes and vaults, and bank safes and vaults;

c) Local burglar alarm units and systems for use in mercantile premises, mercantile safes and vaults, and bank safes and vaults;

d) Proprietary burglar alarm units and systems;

e) Holdup alarm systems of the remote-station type intended for installation in banks, stores, cashiers' cages, pay offices, and the like.

f) Digital alarm communicator system units, interconnected to or integral, for use with central station burglar alarm systems, proprietary burglar alarm systems, police station-connected burglar alarm systems, and holdup alarm systems.

g) Power supplies used to provide electrical power and standby power for burglar-alarm equipment in accordance with the following:

1) The requirements of this standard;

2) The Standard for Access Control System Units, UL 294;

3) The Standard for Intrusion-Detection Units, UL 639;

4) The Standard for Household Burglar-Alarm System Units, UL 1023;

5) The Standard for Burglary-Resistant Electric Locking Mechanisms, UL 1034; and

6) The Standard for Antitheft Alarms and Devices, UL 1037.

1.2 Central station burglar alarm

1.2.1 A central station burglar alarm system consists of electrical protection circuits and devices that are transmitted automatically to, recorded in, maintained from, and supervised from a central (monitoring) station that employs trained operators and alarm investigators who are in attendance at all times and take appropriate action in response to a received signal.

1.2.2 These requirements serve as the basis of classification of central station burglar alarm system transmission methods, however, the requirements covering the complete systems are contained in the Standard for Central-Station Alarm Services, UL 827.

1.3 Police station connected burglar alarm

1.3.1 A police station connected alarm system consists of protective circuits and devices, connected through control apparatus to an optional sounding device mounted on an outside or inside wall of the

building in which the protected property is situated, and a constantly-manned police department or law enforcement center. The connection to a police department may be:

a) Direct, or

b) Through a central (monitoring) station complying with the Standard for Central-Station Alarm Services, UL 827.

1.3.2 Intrusion into or disturbance of the units or wiring causes the sounding device to be actuated (if applicable) and a signal to be transmitted to the police department. The sounding device and signal to the police department continue to operate until it is stopped by using the proper control key, by exhaustion of the power supply, or by action of an automatic timing element that is preset for a definite operating period.

1.3.3 The operation of a police station connected alarm system is partially under the control and domination of the owner or others interested in the property. However, it is required that police station connected systems be maintained under the care and regular inspection service of the installing company. The installing company is expected to respond promptly to troubles or calls for service on report of the owner or police department. It is the responsibility of the owner to switch the system on and off duty and to report malfunctioning of the system to the service company.

1.4 Local burglar alarm

1.4.1 A local alarm system consists of protective circuits and devices, connected through control apparatus to an enclosed tamper-protected sounding device mounted on an outside wall of the building in which the protected property is situated. Intrusion into or disturbance of the units or wiring causes the sounding device to be actuated. The sounding device continues to operate until it is stopped by using the proper control key, by exhaustion of the power supply, or by action of an automatic timing element that is preset for a definite operating period. Local mercantile burglar-alarm systems are intended for the protection of mercantile premises or mercantile safes and vaults. Local bank burglar alarm systems are intended for the protection of bank safes and vaults.

1.4.2 The operation of a local alarm system is partially under the control and domination of the owners or others interested in the property. However, it is required that systems be maintained under the care and regular inspection service of the installing company. The installing company is expected to respond to troubles or calls for service promptly on report of the owner. It is the responsibility of the owner to switch the system on and off duty and to report malfunctioning of the system to the service company.

1.5 Proprietary burglar alarm

1.5.1 A proprietary burglar alarm system as referred to by these requirements is a system in which alarm initiating circuits and devices are installed at a property and are connected directly or indirectly to constantly monitored receiving equipment at a proprietary (monitoring) station. The proprietary (monitoring) station is located at the protected property and intended for operation by personnel responsible to the owner of the protected property.

1.5.2 The protected property may consist of a single property or of noncontiguous properties under a single ownership. The system is arranged so that a predetermined change in the alarm initiating circuits or devices automatically causes transmission of an alarm signal over a supervised signaling channel to the proprietary (monitoring) station.

1.5.3 Proprietary burglar alarm units and systems are also specially designated as to their intended use on mercantile premises, mercantile safes and vaults, and bank safes and vaults.

1.6 Holdup alarm

1.6.1 Holdup alarm systems of the remote-station type intended for installation in banks, stores, cashiers' cages, pay offices, and the like, are to provide a means of transmitting a silent call for help in the event of interior robbery.

1.6.2 A holdup alarm signal shall be transmitted directly to a constantly-manned police station equipped for broadcasting radio calls to cruising squad cars or to a central (monitoring) station with facilities for relaying calls to a law enforcement agency with such broadcasting facilities. The central (monitoring) station shall comply with the Standard for Central-Station Alarm Services, UL 827.

1.7 Digital alarm communicator units

1.7.1 The operation of a digital alarm communicator system is under the control of the owner or others interested in the property, and/or the operators at the monitoring station. A need for off-premises transmission will activate the digital alarm communicator transmitter that contacts a digital alarm communicator receiver located at a monitoring station through the telephone company's switched network (dial system) and transmits a message identifying the change in condition at the protected premises.

1.7.2 A digital alarm communicator system may be classified as police station-connected if:

a) It is used in combination with a protected premises control unit, an optional alarm sounding device, and an alarm housing that complies with this standard; and

b) The signals are transmitted to a digital burglar-alarm communicator receiver located at a central station that complies with Standard for Central-Station Alarm Services, UL 827.

1.8 Burglar alarm power supplies

1.8.1 These requirements cover power supplies for use as components in burglar-alarm system units. The input ratings of power supplies covered by these requirements are not more than 300 volts and the output ratings are low-voltage, power-limited. See 6.19(c). Power supplies integral with a burglar alarm system unit, or separate power supplies intended for use with a specific unit, are covered in the applicable sections of this standard. These requirements may also be covered by the standards specified in 1.1.1(g), as applicable.

1.8.2 Police station connected burglar alarm units, local burglar alarm units, proprietary burglar alarm units, central station burglar alarm units, and digital alarm communicator system units, contain requirements for attack resistance against a power supply providing energy to a local audible alarm sounding device or to a device that will transmit a signal from the protected area to a remote location, such as a central (monitoring) station or police station. A power supply complying with the requirements of this standard that is to be used for any of these purposes shall be capable of being mounted inside an enclosure that will provide the required attack resistance, or shall be provided with an enclosure that will provide the required attack resistance. See Section 67 to determine the attack resistance requirements that will apply.

1.8.3 These requirements do not cover power supplies for use at a central (monitoring) station. Such power supplies are covered by the Standard for Central-Station Alarm Services, UL 827. These requirements do not cover power supplies for use in hazardous locations, as defined in the National Electrical Code, NFPA 70. These requirements do not cover power supplies covered by the Standard for Power Units Other Than Class 2, UL 1012, or battery chargers covered by the Standard for Battery Chargers for Charging Engine-Starter Batteries, UL 1236.

1.9 Common requirements

1.9.1 Protective devices installed on individual properties are further classified as to extent of protection at each location. Requirements covering installation and classification (of extent) of alarm protective equipment at individual locations are published in the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681, which is intended to be referenced by burglar-alarm installers.

1.9.2 If equipment covered by these requirements is intended for use in a combination burglar-alarm and fire-protective signaling system, the portion of the equipment serving a fire-alarm function is covered by the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864, or the Standard for Household Fire Warning System Units, UL 985.

1.9.3 These systems usually operate within the limits of Class 2 remote control and signal circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

1.9.4 A system that provides line security may be classified as either Standard Line Security or Encrypted Line Security. See Standard Line Security Equipment, 40.14, and Encrypted Line Security Equipment, 40.15.

1.9.5 Equipment used in a burglar alarm system shall comply with the requirements for that product and shall not be modified before, during, or after installation into the system, except for software/firmware upgrades as noted in Section 38.

1.9.6 Products intended for use in air-handling spaces in Accordance with Section 300.22, (C) of the National Electrical Code, NFPA 70, are additionally investigated to the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043.

1.9.7 For equipment utilizing power over communications cables, refer to Section 36, Power Over Communications Cable Equipment. Compliance with the Standard for Ethernet, IEEE 802.3 (at or af) specifications shall not be verified as part of these requirements. Refer to Appendix B.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard; or

b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3.2 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

4 Undated References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

5 Terminology

5.1 The term "product" as used in this standard refers to all types of units and systems for all burglar alarm applications noted.

6 Glossary

6.1 For the purpose of this standard, the following definitions apply.

6.2 ACKNOWLEDGMENT SIGNAL – An audible and/or visual signal that is sent to the subscriber by the monitoring station to notify the subscriber that the closing signal has been received, indicating that the protection system has been properly armed. The acknowledgment signal can be sent manually or automatically. Also referred to as "Ringback".

6.3 ADMINISTRATOR – An authorized entity that is in possession of the credentials necessary for the ability to perform an upgrade to a control unit's software and/or firmware.

6.4 AIR-HANDLING SPACE – Space not specifically fabricated for environmental air-handling purposes but used for air handling purposes as a plenum. (The space above a hung ceiling used for environmental air-handling is an example.)

6.5 ALARM INITIATING DEVICE – A device whose operation results in a burglar alarm signal at the control unit. Examples of alarm initiating devices are motion sensors, door/window contact switches, glass break detectors, or the like.

6.6 ALARM SIGNAL – An audible signal indicating a burglar alarm condition requiring immediate action, such as an alarm initiated from an intrusion detector, door switch, floor mat, or the like.

6.7 ALARM SOUNDING DEVICE – An audible signal appliance (bell, horn, siren, or speaker) complying with the requirements in the Standard for Audible Signal Appliances for General Signaling Use, UL 464, and this standard, that is used to signal unauthorized entry or attempted entry into a protected area or object.

6.8 ALARM SOUNDING DEVICE HOUSING – A housing, or the equivalent, that is used to protect an alarm sounding device from being silenced by physical attack. Also see Alarm Sounding Devices, 11.11. There are two versions:

a) Outside – A housing intended to be located outside of the protected area.

b) Inside – A housing intended to be located within the protected area where it can be seen by an intruder.

6.9 ALARM SYSTEM – Protective system consisting of control units, alarm initiating devices, alarm sounding devices, and off-premises communication devices, which emit and transmit remote and local notification of alarm and/or trouble conditions occurring at the protected premises.

6.10 ANNUNCIATOR – A unit containing one or more indicator lamps, alphanumeric displays, computer monitors, audible indicators, or other equivalent means in which each indication provides status information about a circuit, condition, system, or location.

6.11 ARM – The act of turning on the burglar alarm system and setting the protective circuits.

6.12 ARMING STATION (KEYPAD) – A means for manually arming, disarming, or controlling the alarm system. Provided with a visual-indicating device containing identified targets or indicator lamps, alphanumeric displays, audible indicators, or other equivalent means, in which each indication provides status information about a circuit, condition, and/or location.

6.13 AUTOMATION SYSTEM – A computer system that consists of hardware and software components, including the alarm-monitoring software, the operating system, and programming languages, required to make the system operational. An automation system may be configured as a computer system that is directly connected to hardware-based central-station receivers, software-based receivers, or is connected to remote receivers located in central stations other than the one where the automation system is located. It is used to automatically process change-of-status signals such as trouble, supervisory, opening (disarming) and closing (arming), and similar signals that it receives from the central station receiving equipment. Automation systems shall comply with the requirements in the Standard for Central-Station Automation Systems, UL 1981.

6.14 BANK SAFE AND VAULT ALARM SYSTEM – Burglar alarm system located in a bank or financial institution which includes protection for a safe and/or vault.

6.15 BASIC INSULATION – The insulation applied to live parts to provide basic protection against the risk of electric shock. Basic insulation does not necessarily include insulation used exclusively for functional purposes. See also the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

6.16 BIOMETRICS – Authentication of human physical characteristics used to identify an individual.

6.17 CENTRAL STATION – A physically protected building, distributed group of buildings, or an enclosed area within a building, whose ownership is not the same as that of the property(ies) being monitored, that is manned for the purpose of providing immediate attention to defined signals received from the protected property(ies). Also referred to as "Central Station", "Central Supervising Station", "Monitoring Station", or the like.

6.18 CHECK-IN SIGNAL – A signal that is periodically sent by the control unit/communicator to verify that the transmission equipment at the protected property, and the communication path, are operational. A unique signal that is initiated at a pre-established frequency, or an opening, closing, or any other signal sent by the alarm system that occurs within the pre-established frequency, may serve as a check-in signal.

6.19 CIRCUITS, ELECTRICAL:

a) High-Voltage – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage power limited circuit.

b) Low-Voltage – A circuit involving a potential of not more than 30 volts AC rms, 42.4 volts DC, or AC peak.

c) Power Limited – A circuit whose output is limited as specified in Article 725 of the National Electrical Code, and as noted in Table 45.1 and Table 45.2. The power limitation shall be provided by the construction of the transformer, a fixed impedance, a non-interchangeable fuse, a nonadjustable manual reset circuit protective device, or a regulating network.

d) Power over Communications Cable – A limited energy circuit that meets the requirements of Section 36.

e) Risk of Electric Shock – A risk of electric shock is determined to exist within a circuit unless that circuit meets the following criteria:

1) The circuit is supplied by an isolating source such that the maximum open-circuit voltage potential available to the circuit is not more than 30 V AC rms, 42.4 V DC, or 42.4 V peak; and

2) The circuit is supplied by an isolating source such that the current available through a 1500-ohm resistor connected across any potential in the circuit (including to ground) does not exceed 0.5 mA.

3) A limited energy, power over communications circuit that meets the requirements of Section 36.

f) Risk of Fire – A risk of fire is considered to exist at any two points in a circuit where:

1) The open circuit voltage is more than 30 V AC rms, 42.4 V DC, or 42.4 V peak, and the energy available to the circuit under any condition of load including short circuit, results in a current of 8 A or more after 1 minute of operation; or

2) A power of more than 15 watts can be delivered into an external resistor connected between the two points.

Exception: The product meets all of the requirements of Section 36 for equipment utilizing power over communications cables.

6.20 CLOSING SIGNAL – The transmission sent to the monitoring station upon the act of turning on (arming) the burglar alarm system and setting the protective circuits. This signal represents "closing" the business for the day.

6.21 CODE TRANSMITTER SYSTEM – A communication system, such as McCulloh, that provides for the connection of more than one protection system to a single alarm receiving unit at the monitoring station. The code transmitter sends a coded signal to the monitoring station, repeated not less than three times, if the subscriber’s protective circuit is disturbed by an intrusion or unauthorized opening.

6.22 COMMUNICATION CLOUD – The area in the communication path that is supported by providers of communication services in which signals travel between a protected property and a monitoring station. Depending on the type of transmission that is used, signals may travel on a single defined route or through various routes depending upon availability when the signal is initiated.

6.23 COMPUTER SYSTEM, FAULT TOLERANT – A computer system containing multiple power supplies, disk drives, processors, and controllers, each backing up and checking on the processes of others. In the event of a component failure, the other modules take over the function performed by the failed components without affecting the operation of the computer. In addition to the duplicating hardware, a fault-tolerant system includes the necessary software components consisting of the operating system, programming languages, and the alarm monitoring software required to make the system operational. A fault-tolerant computer system is considered to be redundant.

6.24 COMPUTER SYSTEM, REDUNDANT – Two or more computer systems maintained at a monitoring station, either of which can be quickly connected and operational for handling alarm signals in the event that the other computer fails to operate. See 6.23 for the definition of a fault-tolerant computer system. A fault-tolerant computer system is considered to be redundant.

6.25 CONTIGUOUS PROPERTY – A single owner or single user on a continuous plot of ground, including any buildings thereon, that is not separated by a public thoroughfare, transportation right-of-way, property owned or used by others, or body of water not under the same ownership.

6.26 CONTROL UNIT – A unit that directly or indirectly monitors the status of initiating devices, processes any status-change signals, and performs logical control to generate output signals and/or off-premises communication as required by the system type.

6.27 CONTROL UNIT ACCESSORY – A device or appliance externally connected to a control unit that is employed to assure the intended operation of a system or to provide supplementary signaling, annunciation, or both. Examples of control unit accessories are: annunciators, auxiliary relays, end-of-line resistors or diodes, keypads, or remote switches.

6.28 CONTROL UNIT SYSTEM TYPES:

a) Central Station – A system for use with mercantile premises, mercantile safes and vaults, and bank safes and vaults, in which status-change signals at a protected premises are automatically transmitted to a central (monitoring) station where competent and experienced personnel take appropriate action in response to a received signal. The central (monitoring) station is controlled and operated by a person, firm, or corporation whose business includes the furnishing, maintaining, or monitoring of supervised burglar alarm systems.

b) Holdup – Holdup alarm systems of the remote-station type are intended for installation in banks, stores, cashiers' cages, pay offices, and the like, to provide a means of transmitting a silent call for help in the event of interior robbery. Holdup alarms are dispatched upon immediately without the need for any type of alarm verification.

c) Local – A system for use with mercantile premises, mercantile safes and vaults, and bank safes and vaults, which indicates alarm and trouble conditions via alarm sounding devices located at the protected premises.

d) Police Station Connected – A system for use with mercantile premises, mercantile safes and vaults, and bank safes and vaults, in which status-change signals are automatically transmitted to a constantly-manned police station where police authorities take appropriate action in response to a received signal, or to a constantly-manned law enforcement center which dispatches to a police station.

e) Proprietary – A system installed at the protected premises in which status-change signals occurring at the protected premises are automatically transmitted to a constantly manned, on-premises proprietary (monitoring) station where trained, competent personnel take appropriate action in response to a received signal. The protected property may be contiguous or noncontiguous but must be under a single ownership.

6.29 CORD-CONNECTED UNIT – A unit intended for connection to the power source by means of a supply cord. Such a unit is intended to be moved for reasons of interchange or realignment of the units of a system.

6.30 CREDENTIAL – A mechanism that defines or distinguishes the identity of an entity (e.g. a password, PIN, or biometric means).

6.31 CRITICAL COMPONENT – A critical component is one whose malfunctioning will impair the normal operation of the product, or create a risk of fire or electrical shock.

6.32 CROSS ZONING – A means of installing and programming the burglar alarm system in such a way that two or more zones are interdependent in creating an alarm condition. The control panel will not annunciate and/or send an alarm to the monitoring station unless the system detects an alarm condition from two or more zones in a particular area within a preset time window.

6.33 CRYPTOGRAPHIC AUTHENTICATION – Algorithms intended to ensure the secrecy and/or authenticity of messages.

6.34 DEAD METAL PART – A metal or other electrically conductive part, accessible or inaccessible, that is not conductively connected to a live part.

6.35 DIGITAL ALARM COMMUNICATOR RECEIVER (DACR) – A unit located at a monitoring station that will receive and display signals from a digital alarm communicator transmitter (DACT).

6.36 DIGITAL ALARM COMMUNICATOR SYSTEM (DACS) – A system in which signals are transmitted from a digital alarm communicator transmitter (DACT), by cellular and/or telephone landline transmission, to a digital alarm communicator receiver (DACR) located at the monitoring station.

6.37 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT) – A unit located at the protected premises that will contact the digital alarm communicator receiver (DACR) through the public switched telephone network. The DACT seizes the connected telephone line, dials a pre-selected number to connect to a DACR, and transmits the necessary data to identify the DACT and the change of status at the protected premises. As covered by these requirements, the DACT either:

a) Provides all alarm or monitoring control functions; or

b) Interfaces with an alarm or monitoring control unit that provides this function (a slave unit).

6.38 DISARM – The act of turning off the burglar alarm system so that it will no longer annunciate an alarm event (unless a particular circuit is programmed as a "24-hour zone").

6.39 DURESS ALARM – A silent alarm signal generated by the manual entry of a designated code at the system keypad in the event that the user needs assistance, such as when being forced to disarm the burglar alarm system against the user’s will to enter the premises. Duress alarms are typically treated as holdup alarms by monitoring station personnel and are dispatched upon immediately without the need for any type of alarm verification.

6.40 ENCRYPTION – The process of transforming information/data using an algorithm to make it unreadable to anyone except those authorized, usually referred to as a key.

6.41 END-OF-LINE DEVICE – A device installed at the end of a circuit for the purpose of monitoring the circuit for fault conditions.

6.42 ENDSPAN – A device that is typically a network switch capable of supplying power over a communications circuit.

6.43 ENTITY – Person, device, and/or appliance or service which interacts with a control unit.

6.44 ENTRY/EXIT DELAY – A time delay on an entry/exit zone of a burglar alarm system that enables the user to enter the protected premises and disarm the system, or arm the system and exit the protected premises, without creating an alarm condition.

6.45 ETHERNET CABLING – A structured cabling system using 4 pair unshielded or shielded twisted pair cable, meeting Category 5e performance or higher and conforming to the Standard for Balanced Twisted-Pair Telecommunications Cabling and Components, ANSI/TIA-568C.2, requirements. The extent of the cabling is taken to be the channel that connects the appropriate port of the network switch to the powered device.

6.46 EVENT LOG – A comprehensive data record, maintained at the monitoring station and/or control unit, of the events that are associated with remote access.

6.47 FALSE ALARM – An annunciation and/or transmission by the burglar alarm system indicating the occurrence of an alarm condition when no evidence of an actual alarm event is found.

6.48 FAULT – An open, ground, or short-circuit condition on any line extending from a product.

6.49 FIELD WIRING – Conductors to be installed by qualified personnel to connect a product to source(s) of supply, devices, other products, and loads.

6.50 FIRMWARE – A software program or set of instructions programmed on a hardware device (e.g. Flash ROM, EPROM).

6.51 FIXED EQUIPMENT – A device intended to be permanently connected electrically.

6.52 GROUND FAULT – A circuit impedance to ground sufficient to result in the annunciation of a trouble condition.

6.53 HANDSHAKE SIGNAL – For Digital Alarm Communicator Systems (DACS), upon the occurrence of an event requiring off-premises signaling, the phone line is seized and automatically dials the monitoring station receiver. Upon answering, the receiver sends out a special tone ("handshake") which lets the DACT know that the DACR is ready to receive data transmission.

6.54 HARDWARE – Physical equipment that constitutes the components of a burglar alarm system.

6.55 HARDWARE KEY DEVICE – A mechanical or electronic device employed to enable the remote programming mode.

6.56 HOLDUP ALARM INITIATING DEVICE – A switch operated by hand or foot, by key, by removal of currency bills, or by other means to initiate a holdup alarm signal.

6.57 HOLDUP ALARM – A silent alarm generated by the manual or semiautomatic activation of a designated device intended to signal a robbery in progress. Holdup alarms are dispatched upon immediately without the need for any type of alarm verification.

6.58 HOSTED CENTRAL STATION – A hosted central station consists of services not limited to the storage of data from alarm monitoring software, data center equipment co-location, housing the automation system running alarm monitoring software, housing the receivers and automation system, or any combination thereof. Hosted central stations shall comply with the requirements of the Outline of Investigation for Hosted Central Station Services, UL 827A, the Standard for Central-Station Services, UL 827, and/or the Standard for Central-Station Automation Systems, UL 1981, as appropriate.

6.59 HVAC SYSTEM – Heating, Ventilating, and Air-Conditioning system.

6.60 INTERIOR ZONE – A protective circuit connected to a sensing device, such as a motion detector, which only monitors the interior of the premises.

6.61 KISS-OFF SIGNAL – For Digital Alarm Communicator Systems (DACS), after the monitoring station receives the transmission data, it sends a sign-off tone ("kiss-off") to the DACT to end the call and release the phone line.

6.62 LINE SECURITY, ENCRYPTED – In addition to Standard Line Security as noted below, Encrypted Line Security utilizes encryption algorithms with a minimum of 128 bits of security strength to provide data protection against a compromise attempt. Also see Encrypted Line Security Equipment, 40.15.

6.63 LINE SECURITY, STANDARD – Methods of supervising the communication channel used to transmit signals between the protected premises and the monitoring station. This supervision serves to detect compromise attempts on the communication channel that are intended to prevent signals from being annunciated at the monitoring station and which may allow entry into the protected premises without initiating a signal at the monitoring station. Also see Standard Line Security Equipment, 40.14.

6.64 LINE VOLTAGE – The voltage at any field connected source of supply, nominally 50 – 60 hertz, and either 115, 208, or 230 volts.

6.65 LIVE PART – A part:

a) That is conductively connected either:

1) To the power-supply circuit; or

2) To a secondary circuit that operates at more than 42.4 volts peak with reference to ground or accessible metal; and

b) In which the available current measured through a 1500-ohm resistor shunted with a 0.15-µF capacitor connected from the part to ground or to any other accessible part exceeds 0.25 mA.

6.66 LOCAL ALARM – An alarm annunciation at the protected premises caused by activation of an alarm sounding device.

6.67 LOCAL AREA NETWORK (LAN) – A combination of personal computers, servers, and communication devices that are connected to share data files, resources and applications located in close proximity, such as on the same floor or in the same or nearby building(s).

6.68 LONG-RANGE RADIO-FREQUENCY DEVICES – Any device that communicates between a protected premises and a monitoring station, subsidiary station, or another protected premises using a private radio network.

6.69 MANAGED FACILITIES-BASED VOICE NETWORK (MFVN) – A physical facilities based network capable of transmitting real-time packet switched data network (PSDN) signals with unchanged formats, that is managed, operated, and maintained by the service provider to ensure service quality and reliability from the subscriber location to public switched telephone network (PSTN) interconnection points or other MFVN peer networks. Also referred to as "Voice over IP (VoIP)".

6.70 MERCANTILE PREMISES SYSTEM – Burglar alarm system located in a place of business primarily under the control of the owner or others interested in the property.

6.71 MERCANTILE SAFE AND VAULT SYSTEM – Burglar alarm system located in a mercantile establishment which includes protection for a safe and/or vault.

6.72 MESSAGE(S) – Communicated data that contains specific information relating to the product and is transmitted via a wired or wireless pathway from an origin to a destination.

6.73 MIDSPAN – A midspan device is Power Sourcing Equipment (PSE) that injects power onto communications cable. It is located between the network switch and the Powered Device (PD).

6.74 MONITORING STATION – Term used throughout the standard to represent one of more of the following applications: Central Station (see 6.17), Police Station (see 6.89), or Proprietary Station (see 6.99).

6.75 MULTIPLEXING – A signaling method using wire path, cable carrier, radio, or combinations of these methods characterized by the simultaneous and/or sequential transmission and reception of multiple signals in a communication channel including means for positively identifying each such signal.

6.76 NETWORK SWITCH – Active electronic equipment that selects a path or circuit for sending a unit of data to its next destination.

6.77 NORMAL STANDBY CONDITION – The ready-to-operate condition of the product existing prior to its being tripped or operated by an intrusion.

6.78 OFF-HOOK – The condition in which a connection has been established with the Public Switched Telephone Network (PSTN) in preparation for dialing a telephone number.

6.79 ON-HOOK – The condition causing the equipment to disconnect from (hang up) the Public Switched Telephone Network (PSTN).

6.80 ONE-WAY RADIO (RF) – A system in which alarm system signals are transmitted from a radio alarm transmitter through a radio channel to at least two independently-powered, independently-operating, and separately-located radio repeaters or radio alarm monitoring station receivers, or by one of each. At least two separate paths shall be provided from the radio alarm transmitter to the ultimate radio alarm monitoring station receiver.

6.81 OPEN CIRCUIT FAULT – A circuit impedance increase sufficient to prevent normal operation.

6.82 OPENING SIGNAL – The transmission sent to the monitoring station upon the act of turning off (disarming) the burglar alarm system and protective circuits. This signal represents "opening" the business for the day.

6.83 PACKET SWITCHED DATA NETWORK (PSDN) – A type of data transmission in which data is divided into packets, each of which has a destination address. Each packet is then routed across a computer network. A packet may travel a different route than packets related to it. Internet Protocol (IP), Global System for Mobile (GSM), and General Packet Radio Service (GPRS) are examples of PSDN technology.

6.84 PANIC ALARM – An alarm generated by the manual activation of a designated device intended to signal a response to a threat. Panic alarms are dispatched upon immediately after alarm verification by the monitoring station.

6.85 PARTITION – Segmented section of a burglar alarm system that can be armed and disarmed independent of other areas, but operated under a single system control.

6.86 PERIMETER ZONE – A protective circuit connected to a sensing device, such as a door/window contact switch, which monitors an entry point of the protected premises.

6.87 PLAINTEXT – A character representation that is plainly readable as text and not masked and/or hidden.

6.88 POLICE DEPARTMENT – Any local or government-related law enforcement agency.

6.89 POLICE STATION – A physically protected building, distributed group of buildings, or an enclosed area within a law enforcement agency, that is constantly manned by police authorities for the purpose of providing immediate attention to defined signals received from the protected property(ies).

6.90 POLLING DATA LOOPS – An installation wiring circuit in which each device or component of an alarm system that is attached to the loop is polled to verify the continuity of the circuit.

6.91 POLLING SIGNAL – A signal that is periodically sent by the central/proprietary (monitoring) station to verify that the protected premises communication equipment, and the communication path, are operational.

6.92 PORTABLE EQUIPMENT – Cord- and plug-connected equipment that is capable of being carried or moved about.

6.93 POWER INJECTOR (INJECTOR/POWER BRICK) – Power sourcing equipment (PSE) similar to a midspan device, comprising three ports. These are:

a) Data in, typically from the network switch,

b) Data and power – nominal 48 or 53 VDC out, and

c) Line voltage from a utility supply.

6.94 POWER OVER COMMUNICATIONS CABLES – A means to supply DC power to a network device over communications cabling. The power supplied to the device may or may not be on the same conductors supporting data. Typical technologies include PoE (see Appendix B) and USB.

6.95 POWER SOURCING EQUIPMENT (PSE) – The power supply that provides DC power to the powered device (PD) through the communications cabling. It may be an endspan device, such as an enabled network switch, or a midspan device that is located in between the network switch and the powered device.

6.96 POWERED DEVICE (PD) – A device that receives DC power from the power sourcing equipment (PSE) through communications cabling. Also referred to as the load.

6.97 PRIMARY BATTERY – Any battery which, by design or construction, is not intended to be recharged.

6.98 PRIMARY POWER – Power provided by a commercial source available at the protected premises.

6.99 PROPRIETARY STATION – A physically protected building, distributed group of buildings, or an enclosed area within a building, having the same ownership as that of the properties being monitored, that is constantly manned for the purpose of providing immediate attention to all signals received from the protected areas and/or property(ies). Also referred to as "Central Supervising Station", "Central Supervisory Station", or the like.

6.100 PROTECTED PREMISES – Any building or part of a building that has a complete physical boundary. Examples of premises include stores, banks, offices, manufacturing facilities, warehouses, lofts, and stockrooms, and similar locations, used for the storage, manufacturing, sale, or handling of merchandise, valuables, and the like.

6.101 PUBLIC SWITCHED TELEPHONE NETWORK (PSTN) – An assembly of communications equipment and telephone service providers that may utilize Managed Facilities-Based Voice Networks (MFVN) to provide the general public with the ability to establish communications channels via discrete dialing codes. (Source NFPA 72, 2010 edition).

6.102 RADIO FREQUENCY – Electromagnetic radiation, nominally above 20 kilohertz.

6.103 REINFORCED INSULATION – An improved basic insulation with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against the risk of electric shock as double insulation. It may consist of one or more layers of insulating material. See, also, the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

6.104 REMOTE ACCESS – The act of accessing a control unit at a distance from the protected premises, whereby the user does not have visual contact of the premises. Key FOB's are not included in this definition because they are intended to be used when in visual contact with the protected premises and are very limited in the distance they may be used.

6.105 REMOTE COMMUNICATION – Data exchange in which information is exchanged between the control unit and an authorized entity. Information exchanges such as remote monitoring, remote interaction, and software downloading would be considered remote communication.

6.106 REMOTE OPERATION – The function or actuation of the protected premises control unit via remote communication.

6.107 RESET – A control function that attempts to return a system or device to its Normal Standby Condition or non-alarm state.

6.108 SAFETY CIRCUIT – Any primary or secondary circuit that is relied upon to reduce the risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons (an interlock circuit, for example).

6.109 SATELLITE/SUBSIDIARY STATION – A normally unattended physically secure facility linked by communication channels to a central (monitoring) station. Signals from protected properties are transmitted to the subsidiary station and then relayed to the central (monitoring) station. If the communication link between the subsidiary station and the central (monitoring) station is out of service, the subsidiary station can be staffed and operated as a central (monitoring) station.

6.110 SECONDARY BATTERY – Any battery which, by design or construction, is intended to be recharged.

6.111 SECONDARY/STANDBY POWER – Power provided from a secondary source, such as a battery, upon the loss of primary power.

6.112 SHORT CIRCUIT FAULT – A short circuit (wire-to-wire) fault is determined to be a resistance of 0.1 ohm or less across the circuit.

6.113 SHORT-RANGE RADIO-FREQUENCY DEVICES – Any device that communicates with control/receiving equipment at the protected premises by low-power radio signals in accordance with the Code of Federal Regulations (CFR) 47, Part 15.

6.114 SOFTWARE – Programs, instructions, procedures, data, and the like that are temporarily or permanently stored in the computer's memory or central processing unit (CPU) of a product, and are used to provide function and control of the computer's components, or are executed by the CPU of a product to influence the functional performance of that product.

6.115 SOFTWARE-BASED RECEIVING EQUIPMENT – Software packages that are installed in UL 60950-1 or UL 62368-1 evaluated Information Technology Equipment (ITE) network servers, configured to store messages in a compatible database. The software and hardware combination is intended to serve the same function as a traditional dedicated hardware receiving unit at the monitoring station. The software supports all of the signal-receiving, -recording and -supervision functions necessary for the normal operation of the associated subscriber's control units installed within a protected property.

6.116 STATIONARY EQUIPMENT – Cord- and plug-connected equipment that is intended to be fastened in place, or located in a dedicated space.

6.117 SUBSCRIBER – The user of the premises or item protected by a burglar alarm system. An authorized representative of the user may also be considered a subscriber.

6.118 SUPPLEMENTARY INSULATION – An independent insulation provided in addition to the basic (formerly functional) insulation to protect against the risk of electric shock in case of mechanical rupture or electrical breakdown of the basic insulation. An enclosure of insulating material may form a part or the whole of the supplementary insulation. See, also, the requirements for the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

6.119 SYSTEM DATABASE – Information entered into the computer by authorized personnel including items such as, but not limited to, names, addresses, telephone numbers, security information for system users, graphics and the like.

6.120 TRANSMISSION METHODS – Any of the following communication methods: code transmitter, DACT (telephone line, cellular, or MFVN), multiplex, one-way radio (RF), packet switched data network, or two-way radio (RF).

6.121 TRANSMISSION PATH, DUAL – Communication signals from a protected property to a remote monitoring station are sent by different transmission techniques, which pass through separate demarcation points as they leave the protected property.

6.122 TRANSMISSION PATH, SINGLE – Communication signals from a protected property to a remote monitoring station are sent by a single transmission technique and pass through a single demarcation point as they leave the protected property.

6.123 TRANSMISSION PATH (SINGLE/DUAL), ALTERNATE PRIMARY – A method of activating one or more transmission paths to maintain the same level of supervision without interruption.

6.124 TROUBLE SIGNAL – A visual or audible signal indicating a fault condition of any nature, such as an open circuit, ground fault or other trouble condition, occurring in the product or connected wiring.

6.125 TRUSTED PHYSICAL PATH – A contiguous and direct path for communications constructed of physical media. A directly connected crossover network cable, USB cable, or vendor approved cable would be considered a trusted path.

6.126 TWO-WAY RADIO (RF) – A system in which alarm system signals are transmitted and received through a radio channel between a radio alarm transmitter/receiver and a radio alarm monitoring station. The signals may or may not be relayed through a radio repeater. A two-way radio system shall be considered as a multiplex system.

6.127 UNINTERRUPTIBLE POWER SUPPLY (UPS) – Equipment that will continue to provide alternating current (AC) power to a load in the event of failure of the normal AC power source. A UPS may also provide a more constant voltage and frequency supply to the load. When the normal source of AC fails, the UPS is powered by a DC source from batteries, an uninterruptible battery system (UBS), or both.

6.128 USER – A person who has authorized access to the control unit or system.

6.129 USER VALIDATION – The act of an electronic device, upon the input of "user credentials", validating that the credentials are legitimate, allowing the user to proceed to access the system, or upon failure to match the credentials, deny access to the system.

6.130 WIDE AREA NETWORK (WAN) – A WAN differs from a LAN in that a WAN makes data connection across a broad geographic area. Companies use a WAN to connect to various company sites so that information can be exchanged between distant offices.

6.131 ZONE – A defined area within the protected premises from which a status indication can be received or an area in which control can be executed.

7 Information Required for Assessment

7.1 The following documentation shall be required as applicable to determine compliance, and shall be furnished with the sample(s) submitted for investigation:

a) Installation and operating instructions intended to accompany each product or component as produced (see Section 91);

b) Schematic diagrams of all circuits;

c) Printed wiring board construction drawings (e.g. component layouts, foil patterns);

d) Bill of Materials (BOM)/parts list (including manufacturer name and part number for critical components);

e) Mechanical drawings; and

f) Markings to be applied to the product as required in Markings, Section 89.

8 Version Number

8.1 If reprogrammable, a unit, system, or equipment shall provide some method to identify the current version of the software, firmware, and/or programming logic code being used. Subversions that are used to distinguish non-critical logic changes are not required to be identified. This information shall also appear in the product installation instructions.

CONSTRUCTION

ASSEMBLY

9 General

9.1 Specific product requirements

9.1.1 Products that currently meet all the requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, fulfill the requirements of 9.3 (Electrical Protection), 10 (Servicing Protection), 11.1, 11.3 – 11.10 (Enclosure), 12 (Electric Shock), 13 (Corrosion Protection), 14 (Field Wiring Connections, General), 15 (Cord Connected Products), 18 (Grounding), 19 (Internal Wiring, General), 20 (Wiring Methods), 22.1 (Mounting of Components), 22.2 (Insulating Materials), 22.3 (Current-Carrying Parts), 24 (Printed-Wiring Boards), 25 (Transformers and Coils), 27 (Across-the-Line Components), 30 (Switches), and 33 (Spacings, General).

9.2 Product assembly

9.2.1 A product shall use materials that have been determined to comply with the requirements for the particular use, as indicated by the performance requirements of this standard.

9.2.2 The product shall be factory-built as a complete assembly and shall include all the components necessary for its intended function when installed and used as intended. The product may be shipped from the factory as two or more major subassemblies. See 9.2.3.

9.2.3 If the product is not assembled by the manufacturer as a complete unit, it shall be arranged in major subassemblies. Each subassembly shall be capable of being incorporated into a complete assembly without requiring alteration, cutting, drilling, threading, welding, or similar tasks by the installer. Two or more subassemblies, which must bear a definite relationship to each other for the correct installation or operation of the product, shall be arranged and constructed to permit them to be incorporated into the complete assembly only in the correct relationship with each other as indicated in the product installation instructions without the need for alteration or alignment, or such subassemblies shall be assembled, tested, and shipped from the factory as one unit.

9.3 Electrical protection

9.3.1 Louvers and other openings in the enclosure shall be constructed and located to reduce the risk of unintentional contact with uninsulated high-voltage live parts or film-coated wire. In determining compliance with this requirement, parts such as covers, panels, and grilles used as part of the enclosure are to be removed unless tools are required for their removal or an interlock is provided. See also Servicing Protection, Section 10.

9.3.2 Uninsulated high-voltage live parts shall be located, guarded, or enclosed as indicated in 11.3.1.1 – 11.3.1.3.

9.3.3 Knockouts or openings in an alarm sounding device housing for the connection of circuits shall be in the mounting surface only.

9.3.4 If provision is made for testing the condition of a product, such as a power supply, the means provided shall not result in a risk of electric shock, fire, or injury to persons.

10 Servicing Protection

10.1 General

10.1.1 Uninsulated live parts of high-voltage circuits, hazardous moving parts, and sharp corners and projections within the enclosure, shall be formed, located, guarded, or enclosed so as to reduce the risk of unintentional contact by persons performing service functions that may be performed while the equipment is energized.

10.1.2 During the examination of a product in connection with the requirements in 10.1.1, a part of the outer enclosure that may be removed without the use of tools, or part of the outer enclosure that may be removed by the user to allow access for making routine operating adjustments, shall be disregarded; and it shall be assumed that the removable part in question does not afford protection against the risk of electric shock.

10.1.3 The following are not considered to be uninsulated live parts:

a) Coils of relays and solenoids, and transformer windings, if the coils and windings are provided with insulating overwraps rated for the potentials encountered;

b) Terminals and splices with insulation rated for the potential encountered; and

c) Insulated wire.

10.2 Trained service personnel

10.2.1 When the linear distance from a component requiring servicing or an operating switch and any uninsulated current-carrying parts of high-voltage circuits is less than 6 inches (152 mm), then protection by properly applied insulating tape, barriers, or equivalent, shall be provided.

Exception: Not applicable for products complying with the Electric Shock Current Test, Section 51.

10.2.2 Insulating barriers, or equivalent required by 10.2.1 shall be permanently and prominently marked with the cautionary marking “CAUTION – High Voltage” or equivalent.

10.2.3 In lieu of the minimum 6 inches (152 mm) requirement only for serviceable components, the product shall comply with one of the following:

a) An interlock shall be provided on the cover to de-energize all live parts in the enclosure; or

b) The following permanent and prominent marking shall be provided on the cover front: "CAUTION – De-Energize Unit Prior To Servicing."

10.3 Antenna terminal discharge assembly

10.3.1 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The conductive connection shall have a maximum resistance of 5.2 MΩ, a minimum wattage rating of 1/2 W, and shall be effective with the power switch in either the on or off position.

Exception No. 1: The conductive connection need not be provided when:

a) Such a connection is established in the event of electrical breakdown of the antenna isolating means;

b) The breakdown does not result in a risk of electric shock; and

c) In a construction using an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 MΩ.

Exception No. 2: A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna-isolating capacitors is to be rated a minimum of 1/4 W.

Exception No. 3: The requirement is not applicable for antennas that are completely insulated with no accessibility to the risk of electric shock.

10.3.2 The maximum value of 5.2 MΩ specified in 10.3.1 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 MΩ with 20 % tolerance or a resistor rated 4.7 MΩ with a 10 % tolerance.

11 Enclosures

11.1 General

11.1.1 All electrical parts of a product shall be enclosed to provide protection of internal components and prevent contact with uninsulated live parts.

11.1.2 Operating parts, such as gear mechanisms, light-duty relays, and similar devices, shall be enclosed to protect against malfunction due to dust or other material which may impair their intended operation.

11.1.3 The enclosure of a product shall have the strength and rigidity to resist total or partial collapse and the attendant reduction of spacings, loosening or displacement of parts, or other defects. See the Mechanical Strength Tests for Enclosures, Section 66.

11.1.4 Internal parts such as the printed wiring board, power supply, etc., shall be provided with a means for mounting.

11.1.5 An enclosure containing other than power-limited circuits shall be constructed to reduce the possibility of emission of flame, flaming or glowing particles, or flaming drops. See the Abnormal Operation Test, Section 58, and/or the Ignition Test Through Bottom-Panel Openings per the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

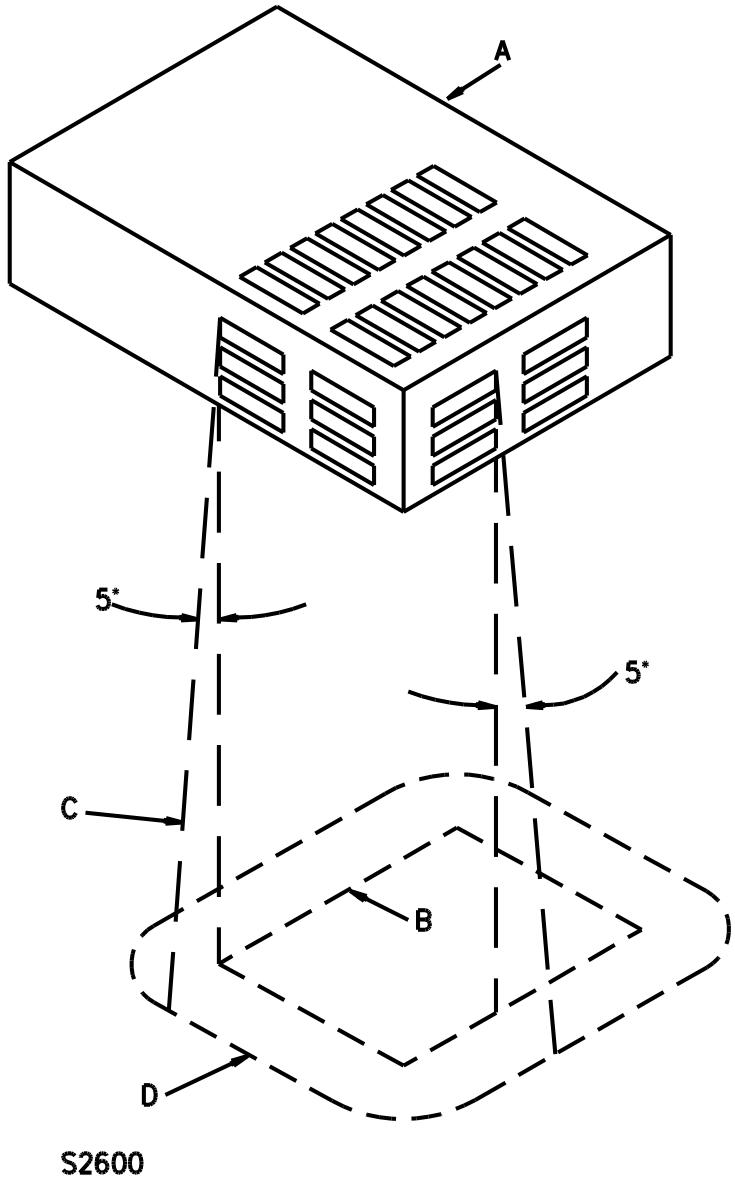
11.1.6 The requirement in 11.1.5 necessitates either a nonflammable bottom in accordance with the requirements in 11.3.4.2, or a protective barrier as illustrated in Figure 11.1 under all areas containing combustible materials.

Exception: Openings not larger than 1/16 square inch (40.3 mm^2) may be provided for the bottom of the enclosure under areas containing only materials rated V-1 or less flammable. See 11.3.4.3.

11.1.7 A construction employing individual barriers under components, groups of components or assemblies, as illustrated in Figure 11.1, is considered to comply with the requirement in 11.1.5.

Figure 11.1

Enclosure Bottom



A – The entire component under which an enclosure (flat or dished with or without a lip or other raised edge) of noncombustible material is to be provided. The sketch is of an enclosed component with ventilation openings showing that the enclosure is required only for those openings through which flaming parts are to be emitted. When the component or assembly does not have its own noncombustible enclosure, the area to be protected is the entire area occupied by the component or assembly.

B – Projection of the outline of the area of A that requires a bottom enclosure vertically downward onto the horizontal plane of the lowest point on the outer edge D of the enclosure.

C – Inclined line that traces out an area D on the horizontal plane of the enclosure. Moving around the perimeter of the area B that requires a bottom enclosure, this line projects at a 5° angle from the line extending vertically at every point around the perimeter of A and is oriented to trace out the largest area; except that the angle shall be less than 5° when the enclosure bottom contacts a vertical enclosure or side panel, or when the horizontal extension of the enclosure B to D exceeds 6 inches (152 mm).

D – Minimum outline of the enclosure, except that the extension B to D is not required to exceed 6 inches (152 mm), flat or dished with or without a tip or other raised edge. The bottom shall either be flat or formed in any manner when every point of area D is at or below the lowest point on the outer edge of the enclosure.

11.2 Doors and covers

11.2.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached so it cannot be removed if it:

a) Gives access to fuses or any other overcurrent protective device, the intended functioning of which requires renewal or resetting; or

b) Is necessary to open the cover in connection with the intended operation of the unit.

Exception No. 1: If the cover position is supervised by a tamper contact that is connected in the closed protective circuit, an enclosure need not comply with the requirements of this paragraph. See also 41.10.

Exception No. 2: These requirements do not apply to a product located at a monitoring station.

11.2.2 Fasteners requiring the use of a tool or key shall be used for the assembly of all enclosures if access is not required for operation of the product.

Exception: This requirement does not apply to a product located at a monitoring station.

11.2.3 The cover of an enclosure shall be provided with a supervisory contact, connected in the closed protective wiring circuit, if it gives access to any relays, terminals, controls, or related components that might be subject to tampering without causing an alarm or trouble signal. See also 41.10.

Exception: An enclosure located inside of a completely protected safe or vault does not require tamper protection.

11.3 Enclosure openings

11.3.1 General

11.3.1.1 Openings in the enclosure shall be constructed and of such size so that direct entry of foreign objects is prevented. See also 11.3.2.1. See Figure 11.4 for examples of acceptable top cover constructions that are deemed to prevent direct entry. See also Figure 11.5 for acceptable side opening constructions.

11.3.1.2 An opening in an electrical enclosure that does not permit entrance of a 1 inch (25.4 mm) diameter rod shall be sized and arranged so that a probe, as illustrated in Figure 11.2, cannot be made to contact any uninsulated live part (other than low-voltage) when inserted through the opening in a straight or articulated position. The probe illustrated shall be applied to any depth that the opening will permit and rotated or angled before, during, or after insertion through the opening to any position that is required in order to examine the enclosure.

11.3.1.3 An opening that permits entrance of a 1 inch (25.4 mm) diameter rod is acceptable under the conditions described and illustrated in Figure 11.3.

Figure 11.2

Accessibility Probe with Web Stop

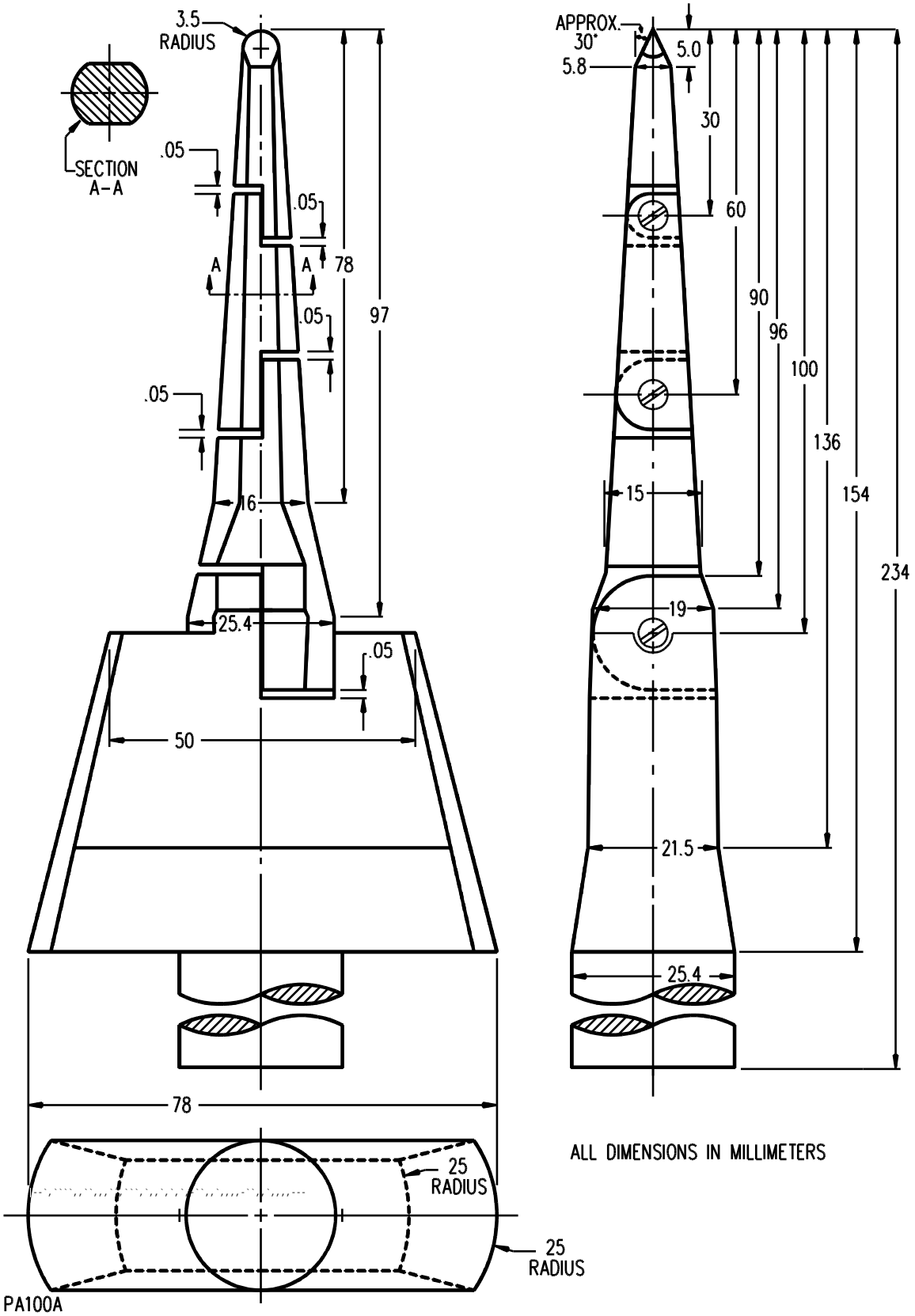
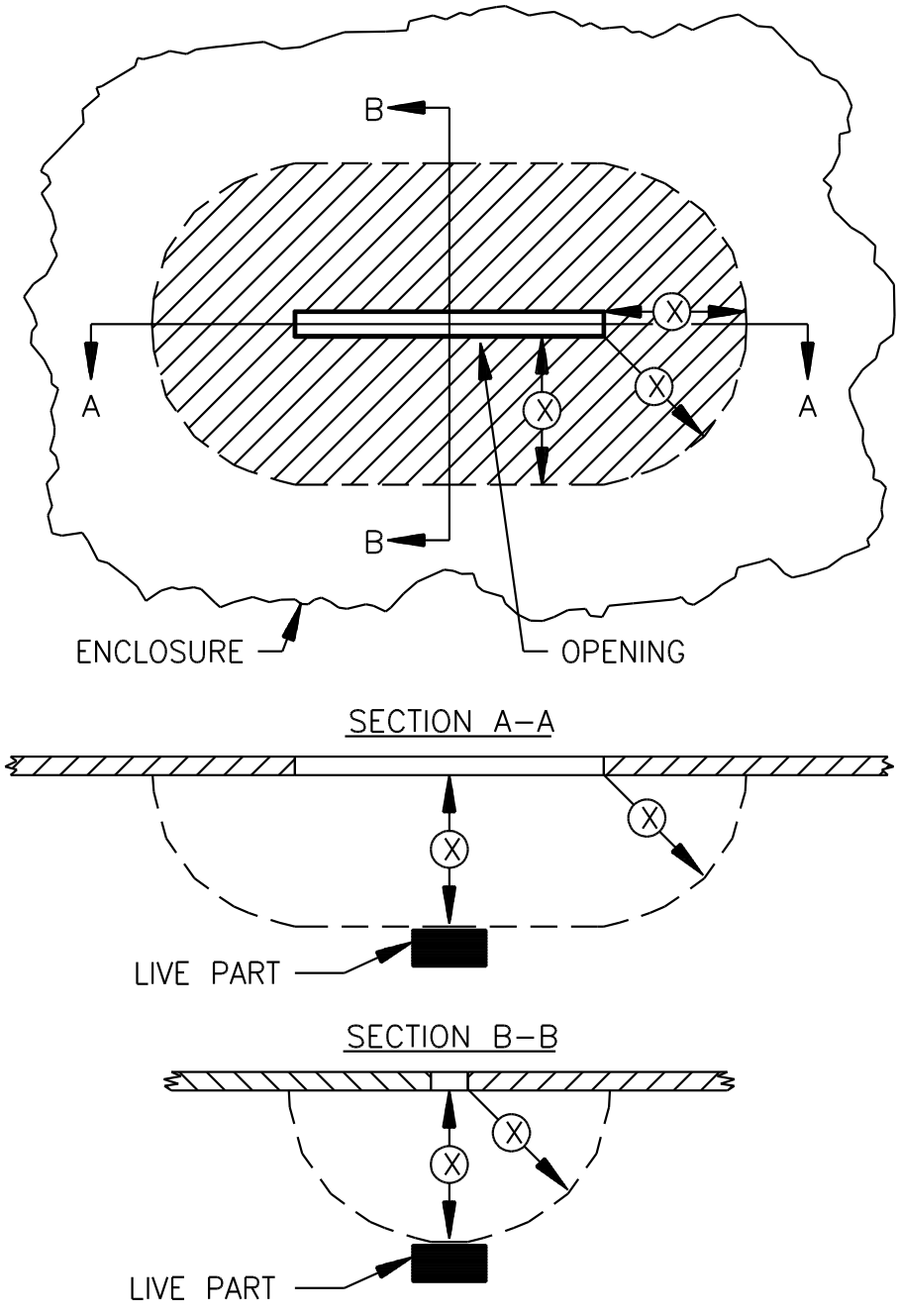


Figure 11.3

Opening in Enclosure



NOTE – The opening may be used if, within the enclosure, there is no uninsulated live part or film coated wire:

a) Less than X inches (mm) from the perimeter of the opening, as well as;

b) Within the volume generated by projecting the perimeter X inches (mm) normal to its plane.

X equals five times the diameter of the largest diameter rod that can be inserted through the opening, but not less than 6-1/16 inches (154 mm).

11.3.1.4 Openings are acceptable, without limitation of the size or number of openings, in areas containing only PVC, TFE, CTFE, FEP, and neoprene insulated wire or cable, in areas containing plugs and receptacles, and in areas underneath impedance protected or thermally protected motors.

11.3.1.5 Openings in the enclosure shall not give access to relays, terminals, controls, or related components that might be subject to tampering by hand or with tools without causing an alarm or trouble signal.

11.3.1.6 An enclosure intended for recessed mounting and whose front panel is to be flush with the surface of the wall shall have no openings that vent into concealed spaces of a building structure, such as into hollow spaces in the wall, when the product is mounted as intended.

Exception: Not applicable for products supplied solely from power-limited sources and controlling only power-limited loads.

11.3.1.7 The requirement in 11.3.1.6 does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) when:

a) An opening for non-mounting purposes does not have a dimension greater than 17/64 inch (6.75 mm) or an area greater than 0.055 ft^2 (35.5 mm^2); and

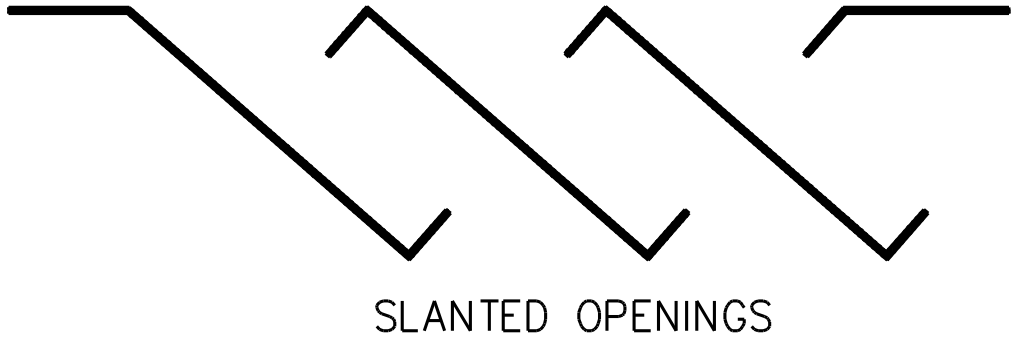
b) An opening for mounting does not have a dimension greater than 0.75 inch (19.05 mm) or an area greater than 0.7 $inch^2$ (430 mm^2) and there are no more holes than are needed to mount the product.

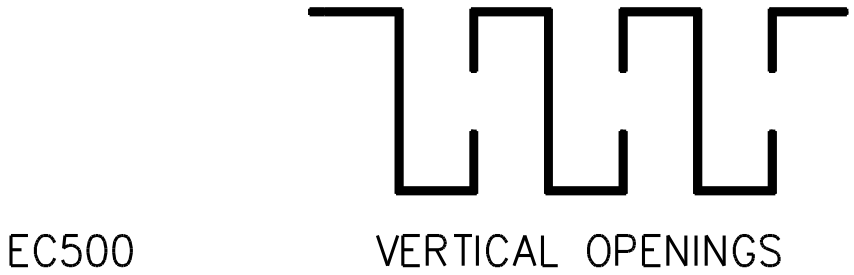
11.3.2 Enclosure top openings

11.3.2.1 Openings directly over uninsulated high voltage live parts shall not exceed 0.20 inch (5.0 mm) in any dimension unless the configuration is such that a vertically falling object cannot fall into the unit and contact an uninsulated live part. For examples complying with the intent of this requirement, see Figure 11.4 for top cover designs.

Figure 11.4

Cross Sections of Top Cover Designs





11.3.3 Enclosure side openings

11.3.3.1 An opening in the side of the enclosure shall:

a) Not exceed 0.20 inch (5.0 mm) in any dimension;

b) Be provided with louvers shaped to deflect an external falling object outward (see Figure 11.5 for examples of louver designs complying with the requirement); or

c) Be located and sized so that objects which are present cannot drop into the unit and fall (with no horizontal velocity) onto uninsulated live parts involving a risk of fire, electric shock, or electrical-energy/high-current levels, or parts involving injury to persons (see Figure 11.6).

Figure 11.5

Louvers

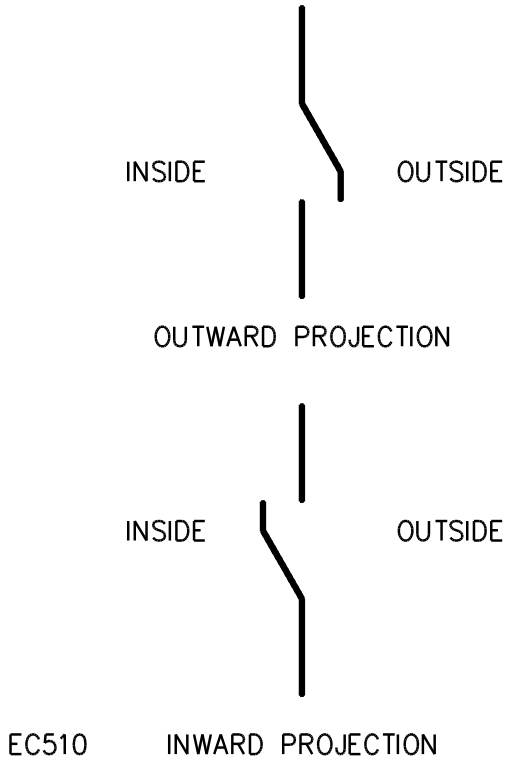
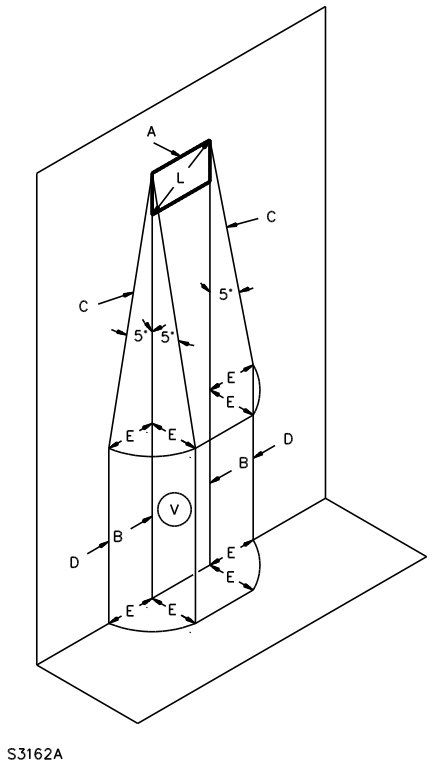


Figure 11.6

Example of Enclosure Side Opening



11.3.3.2 When a portion of a side panel falls within the area traced out by the 5° angle in Figure 11.1, that portion of the side panel shall be investigated as a bottom enclosure in accordance with 11.3.4.1 – 11.3.4.3.

11.3.4 Enclosure bottom openings

11.3.4.1 The bottom of an enclosure shall consist of a complete or partial bottom enclosure under a component, groups of components, or assemblies, as shown in Figure 11.1, that complies with the ventilation opening requirements in 11.3.4.2 and 11.3.4.3 unless a test demonstrates that the bottom enclosure provided contains flames, glowing particles or similar burning debris when all combustible material in the interior is ignited.

Exception: Openings without limitation on their size and number are permitted in areas that contain only wires, cables, plugs, receptacles, and impedance- and thermally-protected motors.

11.3.4.2 Ventilation openings provided in the bottom of an enclosure under materials that are not rated V-1 or less flammable meet the intent of the requirements when the openings are constructed so that materials do not fall directly from the interior of the unit. Other bottom-opening constructions that comply with the intent of the requirements are those that incorporate a perforated metal plate as described in Table 11.1, or a galvanized or stainless-steel screen having a 14 by 14 mesh per 1 inch (25.4 mm) constructed of wire with a minimum diameter of 1/64 inch (0.4 mm). Other constructions are to be used only when they comply with the Ignition Test Through Bottom-Panel Openings per the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

Table 11.1
Perforated Metal Plates

Minimum thickness,		Maximum diameter of holes		Minimum spacing of holes center-to-center	
inch	(mm)	inch	(mm)	inch	(mm)
0.026	(0.66)	0.045	(1.14)	0.067	(1.70)
				[233 holes per in^2]	[36 holes per cm^2]
0.026	(0.66)	0.047	(1.19)	0.093	(2.36)
0.032	(0.81)	0.075	(1.91)	0.125	(3.18)
				[72 holes per in^2]	[11 holes per cm^2]
0.036	(0.91)	0.063	(1.60)	0.109	(2.77)
0.036	(0.91)	0.078	(1.98)	0.125	(3.18)

11.3.4.3 The bottom of the enclosure under areas containing only materials rated V-1 or less flammable shall have openings not larger than 1/16 square inch (40.3 mm^2).

11.4 Screens and expanded metal

11.4.1 Screens or expanded metal used as a guard, enclosure, or part of an enclosure, shall comply with the requirements in 11.4.3 and 11.5.1 and with the Mechanical Strength Tests for Enclosures, Section 66.

11.4.2 Perforated sheet steel and sheet steel employed for expanded metal mesh shall be not less than 0.042 inch (1.07 mm) thick [0.045 inch (1.17 mm) if zinc coated] if the mesh openings or perforations are 1/2 $inch^2$ (323 mm^2) or less in area, and shall be not less than 0.080 inch (2.03 mm) thick [0.084 inch (2.13 mm) if zinc coated] for larger openings. The largest dimension of this material shall not exceed 4 inches (102 mm).

Exception: If the indentation of a guard or the enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to impair performance or reduce spacings below the minimum required values (see Spacings, General, Section 33, and the Mechanical Strength Tests for Enclosures, Section 66), 0.020 inch (0.51 mm) expanded steel mesh or perforated sheet steel [0.023 inch (0.58 mm) if zinc coated] may be employed, when:

a) The exposed mesh on any one side or surface of the product so protected has an area of not more than 72 $inches^2$ (464 cm^2) and has no dimension greater than 12 inches (305 mm); or

b) The width of the opening covered by this material is not greater than 3-1/2 inches (89 mm).

11.4.3 The wires of a screen shall be not less than 16 AWG (1.3 mm diameter) steel if the screen openings are 1/2 $inch^2$ (323 mm^2) or less in area, and shall be not less than 12 AWG (2.1 mm diameter) steel for larger screen openings.

11.5 Cast metal

11.5.1 The minimum thickness of cast metal for an enclosure shall be as indicated in Table 11.2.

Exception: Cast metal of lesser thickness may be employed if, after consideration has been given to the shape, size, and function of the enclosure, it is determined to provide equivalent mechanical strength. See the Drop Test, Section 64, and the Mechanical Strength Tests for Enclosures, Section 66.

Table 11.2
Cast-Metal Enclosures

Use, or dimensions of area involved[a]	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast type,	
	inch	(mm)	inch	(mm)
Area of 24 square inches (155 cm^2) or less and having no dimension greater than 6 inches (152 mm)	1/16	(1.6)	1/8	(3.2)
Area greater than 24 square inches (155 cm^2) or having any dimension greater than 6 inches (152 mm)	3/32	(2.4)	1/8	(3.2)
At a threaded conduit hole	1/4	(6.4)	1/4	(6.4)
At an unthreaded conduit hole	1/8	(3.2)	1/8	(3.2)

[a] The area limitation for metal 1/16 inch (1.6 mm) thickness may be obtained by the provision of reinforcing ribs subdividing a larger area.

11.5.2 If threads for the connection of conduit are tapped through a hole in an enclosure wall, or if an equivalent construction is employed, there shall not be less than 3-1/2 nor more than five threads in the metal, and the construction shall be such that a standard conduit bushing can be attached as intended.

11.5.3 If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall not be less than 3-1/2 full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors that has been determined to provide the same level of protection to the conductors as that of a standard conduit bushing.

11.6 Sheet metal

11.6.1 The thickness of sheet metal for an enclosure shall not be less than that indicated in Table 11.3 or Table 11.4, whichever applies.

Exception: Sheet metal of lesser thickness may be employed if, after consideration has been given to the shape, size, and function of the enclosure, it is determined to provide equivalent mechanical strength. See the Drop Test, Section 64, and the Mechanical Strength Tests for Enclosures, Section 66.

11.6.2 A sheet metal member to which a wiring system is to be connected in the field shall have a thickness of not less than 0.032 inch (0.81 mm) if of uncoated steel, not less than 0.034 inch (0.86 mm) if of galvanized steel, and not less than 0.045 inch (1.14 mm) if of nonferrous metal.

11.6.3 If additional mechanical protection is required by other sections of this standard, the metal thicknesses required by those sections shall take precedence over those shown in Table 11.2 – Table 11.4.

11.6.4 A plate or plug closure for an unused conduit opening or other hole in the enclosure shall have a thickness not less than 0.027 inch (0.69 mm) if of steel or 0.032 inch (0.81 mm) if of nonferrous metal for a hole having a 1-3/8 inch (34.9 mm) diameter maximum dimension.

11.6.5 A closure for a hole larger than 1-3/8 inch (34.9 mm) diameter shall have a thickness equal to that required for the enclosure of the product or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

11.6.6 A knockout in a sheet metal enclosure shall be capable of being removed without excess deformation of the enclosure.

11.6.7 A knockout shall be provided with a surrounding surface of sufficient area to provide for seating of a conduit bushing and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those specified under Spacings, General, Section 33.

Table 11.3
Minimum Thickness of Sheet Metal for Electrical Enclosures – Carbon Steel or Stainless Steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
								Uncoated,		Metal coated,	
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length, inches	(cm)	inches [MSG]	(mm)	inches [GSG]	(mm)
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020	(0.51)	0.023	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)	[24]		[24]	
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026	(0.66)	0.029	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)	[22]		[22]	
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)	[20]		[20]	
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)	[18]		[18]	
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited		0.053	(1.35)	0.056	(1.42)
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)	[16]		[16]	
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited		0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)	[15]		[15]	
25.0	(63.5)	Not limited		39.0	(99.1)	Not limited		0.067	(1.70)	0.070	(1.78)
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)	[14]		[14]	
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080	(2.03)	0.084	(2.13)
38.0	(96.5)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)	[13]		[13]	
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	[12]		[12]	
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited		0.108	(2.74)	0.111	(2.82)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)	[11]		[11]	
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited		0.123	(3.12)	0.126	(3.20)
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)	[10]		[10]	

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

1) Single sheet with single formed flanges (formed edges);

2) A single sheet which is corrugated or ribbed; and

3) An enclosure surface loosely attached to a frame; for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

Table 11.4
Minimum Thickness of Sheet Metal for Electrical Enclosures – Aluminum, Copper, or Brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,			
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch	(mm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited			
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)	0.023	(0.58)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited			
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)	0.029	(0.74)
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited			
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)	0.036	(0.91)
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited			
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)	0.045	(1.14)
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited			
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)	0.058	(1.47)
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited			
20.0	(50.8)	25.0	(63.5)	45.0	(114.3)	55.0	(139.7)	0.075	(1.91)
25.0	(63.5)	Not limited		60.0	(152.4)	Not limited			
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)	0.095	(2.41)
37.0	(94.0)	Not limited		87.0	(221.0)	Not limited			
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)	0.122	(3.10)
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited			
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	160.0	(406.4)	0.153	(3.89)

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

1) Single sheet with single formed flanges (formed edges);

2) A single sheet which is corrugated or ribbed; and

3) An enclosure surface loosely attached to a frame, for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

11.7 Polymeric materials

11.7.1 Polymeric materials used as an enclosure shall comply with the applicable portion of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and also with the additional requirements specified in this standard.

11.7.2 Conductive coatings applied to nonmetallic surfaces such as the inside surface of an enclosure, shall comply with the appropriate requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, unless flaking or peeling of the coating cannot result in the reduction of spacings or the bridging of live parts.

11.7.3 Among the factors taken into consideration when judging the acceptability of a nonmetallic enclosure are:

a) The mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Flammability and resistance to ignition from electrical sources;

e) Dielectric strength, insulation resistance, and resistance to arc tracking; and

f) Resistance to distortion and creeping at temperatures to which the material may be subjected under any conditions of use.

All these factors are considered with respect to aging in accordance with the Polymeric Materials Test, Section 62, and the Mechanical Strength Tests for Enclosures, Section 66.

11.7.4 A polymeric enclosure intended for connection to a rigid metallic or nonmetallic conduit system shall comply with the applicable requirements or polymeric enclosure conduit connections in the Standard for Enclosures for Electrical Equipment, UL 50.

11.7.5 The continuity of a conduit system shall be provided by metal-to-metal contact and not rely on a polymeric material. It shall also comply with the requirements for polymeric enclosure bonding in the Standard for Enclosures for Electrical Equipment, UL 50.

11.8 Internal materials

11.8.1 Polymeric materials used within an enclosure shall be evaluated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: Unrated resistors, capacitors, semiconductors, integrated circuit packages, optical isolators, and similar electrical components meet the intent of the requirement when they are mounted on a material with a minimum flammability rating of V-1.

11.8.2 All combustible material used within an enclosure shall be V-2, HF-2, or better.

Exception No. 1: Motors, relays, capacitors, semiconductors, transformers, switches, insulating tubing or tape, and other electrical elements are exempt from the above requirement when they comply with the flame test applicable to the component. Meter faces and cases (when determined capable for mounting live parts) and indicator lamps or jewels, or both, are exempt from flammability requirements. The following requirements apply to parts that are isolated either by at least 0.5 inch (12.5 mm) of air, or a solid barrier of V-1 or less-flammable material from uninsulated electrical parts that involve a risk from electrical energy-high current levels:

a) Gears, cams, belts, bearings, strain-relief bushings applied over PVC-jacketed cords, and other small parts that contribute negligible fuel to a fire is not required to be investigated.

b) Tubing for air or fluid systems, and plastics, shall not be more flammable than HB. Foamed plastics classed HBF in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, are determined as complying with this requirement.

Exception No. 2: Combustible material used within an enclosure is not prohibited from being HB when the power sources to the enclosure meet the criteria for no risk of fire as defined in 6.19(e).

11.9 Product enclosure mounting

11.9.1 An enclosure shall have means for mounting that shall be accessible without disassembly of any operating part of the product. Removal of a completely assembled panel to mount the enclosure is not considered to be disassembly of an operating part.

11.10 Battery compartments

11.10.1 A compartment for vented storage batteries shall have a total volume at least twice the volume occupied by the batteries. Ventilating openings shall be provided and so located as to permit circulation of air for dispersion of gas while the battery is being charged at the highest rate permitted by the means incorporated in the control unit.

11.10.2 The interior of a storage battery compartment shall be protected so that it will be resistant to detrimental action by the electrolyte, such as two coats of acid-resistant and alkali-resistant paint or by baked enamel.

11.11 Alarm sounding devices

11.11.1 Enclosures employed as a housing to protect an alarm sounding device from being silenced by a physical attack shall comply with the construction requirements in 11.11.2 – 11.11.9, as well as the performance requirements noted in 67.2.2 (Attack Test).

11.11.2 The construction of an inside alarm housing shall:

a) Be equivalent in strength to a 0.053 in (1.35 mm) thick sheet steel enclosure having a steel baffle plate over all louvers or direct sound opening, and

b) Be provided with door or cover securing devices, and otherwise constructed to resist attempts to silence the alarm by the attack methods described in 67.2.3.1.

11.11.3 The construction of an outside alarm housing shall be at least equivalent in strength to a 0.067 in (1.70 mm) sheet steel outer housing and an electrical inner lining of 0.053 in (1.35 mm) sheet steel, covering all sides except the back. An attempt to remove the alarm housing from its mounting surface or an attempt to disassemble it shall result in an alarm signal when the alarm system is set for duty. At least one-half of the outer-cover-securing devices shall be supervised so as to result in an alarm signal if any are removed while the alarm system is set for duty. If the alarm housing is intended for use outdoors, it shall also comply with Sections 71 and 72.

11.11.4 The outer housing and inner lining of an outside alarm housing shall be connected in the closed protection circuit or fully insulated electric linings shall be used so that an alarm will result if the housing is penetrated by drills, pry bars, or similar tools.

11.11.5 Connection of linings, housings, and housing contacts shall be supervised by the closed protection circuit that enters and leaves at different points. If the housing is intended to be grounded, it shall be connected to the correct circuit with respect to single-circuit protection wiring.

11.11.6 For Bank Safe and Vault applications, the alarm housing shall be at least equal in mechanical strength and electrical protection to a 0.123 in (3.12 mm) sheet steel enclosure with an electrically connected lining completely covering the interior of the housing. Mechanical safeguards shall be placed around the ringing mechanism, sources of energy, and the like, to withstand an attack as specified in 67.3.3.

11.11.7 The alarm housings described in 11.11.2, 11.11.3 and 11.11.6, shall be provided with an opening or knockout for the connection of conduit or electrical metallic tubing in the mounting surface of the housing that is to be used for the conductors used to supply power to the alarm sounding device. The opening or knockout in the outside alarm housing shall only be accessible when the cover of the inner housing or lining is removed.

Exception: Such an opening is not required if the power supply for the alarm sounding device is located within the alarm housing.

11.11.8 An inside audible alarm sounding device shall provide for the connection of conduit or electrical metallic tubing or shall provide for mounting to an electrical back box that will provide for such connection.

11.11.9 Alarm housings and their enclosed sounding devices are to be installed in accordance with the requirements noted in UL 681, Standard for Installation and Classification of Burglar and Holdup Alarm Systems.

12 Electric Shock

12.1 Any part that is exposed during operator servicing shall not present the risk of electric shock. See the Electric Shock Current Test, Section 51.

12.2 The replacement of any component used in the product shall not result in a risk of electric shock.

13 Corrosion Protection

13.1 Iron and steel parts, other than bearings, and the like, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means. Bearing surfaces shall be of such materials and construction as to resist binding due to corrosion.

13.2 The requirement of 13.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

Exception No. 1: This requirement does not apply to parts, such as washers, screws, bolts, and the like, if corrosion of such unprotected parts would not be likely to result in a risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons, or to impair the operation of the unit.

Exception No. 2: Parts made of stainless steel, polished or treated, if necessary, do not require additional protection against corrosion.

13.3 Metals shall be galvanically compatible.

Exception: If galvanic action does not impair intended operation of the product, or result in the risk of fire, electric shock, or unintentional contact with moving parts that may cause a risk of injury to persons, this requirement does not apply.

13.4 Hinges and other attachments shall be resistant to corrosion.

13.5 For outdoor use products, also refer to the Corrosion Tests in Section 80.

FIELD WIRING CONNECTIONS

14 General

14.1 Wiring terminals or leads shall be provided for connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70.

15 Cord-Connected Products

15.1 A portable product that is intended to be connected to high-voltage or line voltage branch-circuit supply shall be provided with not less than 6 feet (1.8 m) of flexible cord and grounded attachment plug of acceptable type and rated for connection to the supply circuit.

Exception No. 1: The cord may be less than 6 feet (1.8 m) in length if it is evident that the use of the longer cord may result in damage to the cord or product, or result in a risk of fire, electric shock, or injury to persons, impair intended operation of the product, or is not required for the intended operation of the product.

Exception No. 2: A polarized attachment plug, rather than a grounded attachment plug, is acceptable when the product has no accessible dead-metal parts likely to be energized.

15.2 A flexible cord is acceptable for use with a stationary product.

15.3 The flexible cord shall have a voltage rating not less than the rated voltage of the product, and shall have an ampacity that is not less than the current rating of the product.

15.4 The flexible cord on a cord-connected unit shall be as indicated in Table 15.1 or shall be of a type at least as serviceable for the particular application. 15.2 specifies cord types determined to be equivalent to those specified in Table 15.1.

Table 15.1
Power Supply Cords

Type of appliance	Type of cord
Table-model products (for use on a table, desk, and the like) that are not frequently moved	SV, SP-2, SP-3
Products that are intended for use on desks, counters, or tables and are moved frequently	SV, SP-2
Hand-held products	TS[a], SV[b]
Floor-mounted products	SJ, S
Wall-mounted products	SV[c], SP-2[c], SP-3[c], SJ, S

[a] A tinsel cord shall be used when all of the following conditions are met:

1) The cord is no longer than 8 feet (2.4 m);

2) The cord is attached to the product directly or by means of a plug intended for that purpose;

3) The product rating is not higher than 50 W; and

4) The intended use of the appliance requires an extremely flexible cord.

[b] Type SV and similar cords shall be used when each conductor is made up of 36 AWG (0.01 mm^2) strands.

[c] Type SV, SP-2, SP-3, and similar cords shall be used only when the cord is no longer than 5 feet (1.5 m).

Table 15.2
Equivalent Cords

Basic cord type	Equivalent types
TS	TST
SP-2	SPE-2, SPT-2
SP-3	SPE-3, SPT-3
SV	SVE, SVO, SVOO, SVT, SVTO, SVTOO
SJ	SJE, SJO, SJOO, SJT, SJTO, SJTOO
S	SE, SO, SOO, ST, STO, STOO

15.5 The current rating of the attachment plug shall not be less than 125 % of the product nameplate rating.

15.6 The voltage rating of the attachment plug shall correspond to the rated voltage of the product. When a product is intended for use on two or more different values of voltage by internal connections, the attachment plug provided with the product shall be rated for the voltage for which the product is wired when shipped from the factory.

15.7 A plug-in transformer shall be attached permanently to the power receptacle so as to prevent accidental removal.

Exception: This requirement is not applicable if a local audible trouble signal is annunciated upon loss of primary power.

15.8 The power supply cord shall be provided with strain relief means so that a stress on the cord will not result in strain being transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section 65.

15.9 A knot shall not be used to provide strain relief.

15.10 Clamps of any material (metal or otherwise) are acceptable for use on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

15.11 The supply cord or supply leads shall be prevented from being pushed into the unit through the cord-entry hole if such displacement is likely to:

a) Subject the cord or supply leads to mechanical damage or to exposure to a temperature higher than that for which the cord or supply leads are rated;

b) Reduce spacings (such as to a metal strain-relief clamp) below the minimum acceptable values; or

c) Damage internal connections or components.

16 Permanently-Connected Products

16.1 A fixed product shall have provision for connection of one of the wiring systems that, in accordance with the National Electrical Code, ANSI/NFPA 70, would be acceptable for it.

16.2 A product intended for permanent connection to the branch-circuit supply shall have provision for installing the supply conductors in rigid metallic or non-metallic conduit.

16.3 A knockout or other supply-connection opening located where temperatures in excess of 140 °F (60 °C) have been measured during the Temperature Test, Section 56, and not having qualifying marking as specified in 89.13, shall be sealed by welding or the equivalent or be permanently marked adjacent to the opening with: "Do Not Use".

16.4 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined as specified in Table 16.1.

Table 16.1
Trade Size of Conduit in inches (mm OD)

Wire size		Number of wires									
AWG	(mm^2)	2		3		4		5		6	
14	2.1	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)
12	3.3	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
10	5.3	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
8	8.4	3/4	(26.7)	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)
6	13.3	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)

NOTE – This table is based on the assumption that all conductors will be of the same size and there will not be more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

16.5 The location of a terminal box or compartment in which branch-circuit connections to a permanently-wired product are to be made shall be such that the connections can be readily inspected without disturbing the wiring or the product after the product has been installed as intended.

16.6 A terminal compartment intended for the connection of a supply raceway shall be secured in position and attached to the product to prevent turning.

16.7 The field-wiring compartment area of a product shall be of sufficient size for completing all wiring connections as specified by the installation wiring diagram.

16.8 Where damage to field-wiring insulation may be caused by internal components or sharp edges in the wiring compartment, insulating or metal barriers having smooth, rounded edges shall be provided, or the following or equivalent wording marked in the wiring area shall be present: “CAUTION – When Making Installation, Route Field Wiring Away From Sharp Projections, Corners, and Internal Components”.

16.9 The wiring terminals of a product intended for mounting in an outlet box shall be located or protected so that, upon installation, the wiring in the outlet box is not forced against the terminals or other sharp edges so as to damage the conductor insulation, and/or the terminals or stripped leads do not come into contact with the walls of the outlet box.

16.10 The product shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than 125 % of the current input of the product when connected to a rated source of supply. It is assumed that branch circuit conductors rated 60 °C (140 °F) will be used.

16.11 The free length of a lead inside a terminal box or compartment shall be 6 inches (152 mm) or more, provided with strain relief, shall not be smaller than 18 AWG (0.82 mm^2), and the insulation thickness, when of rubber or thermoplastic, shall not be less than 0.030 inch (0.76 mm) minimum average and 0.027 inch (0.69 mm) minimum at any point when the lead is intended for field connection to an external circuit.

Exception: The lead shall be less than 6 inches (152 mm) long when it is evident that the use of a longer lead results in a risk of fire or electric shock.

16.12 A field-wiring terminal shall be kept from turning or shifting in position by means other than friction between surfaces. This shall be accomplished by two screws or rivets, by square shoulders or mortises, by a dowel pin, lug or offset, by a connecting strap or clip fitted into an adjacent part, or by some other method determined to be the equivalent.

16.13 A field-wiring terminal shall comply with the requirements in 17.2 for field-wiring terminals (general application) except a wire-binding screw shall not have a diameter smaller than No. 8 (4.2 mm).

16.14 A terminal intended for the connection of a grounded supply conductor (neutral) shall be composed of or plated with metal that is white in color and shall be distinguishable from the other terminals, or identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

16.15 A lead intended for the connection of a grounded supply conductor (neutral) shall be finished white or gray color and shall be distinguishable from the other leads.

16.16 A means of strain relief shall be provided for the field supply leads of a product to prevent any mechanical stress from being transmitted to terminals and internal connections. Inward movement of the leads provided with a ring-type strain relief or means determined to be the equivalent shall not damage internal connections or components, or result in a reduction of electrical spacings. See the Strain Relief Test, Section 65.

17 Other Field-Wiring Connections

17.1 General

17.1.1 A product shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70, corresponding to the rating of the circuit.

17.1.2 All field-wiring connections shall be contained in either an enclosed field wiring compartment integral with the product or in a separate outlet box to which the product is to be mounted.

17.1.3 Duplicate terminals or leads, or an equivalent arrangement, shall be provided for circuits of products intended to be connected to initiating-device circuits, notification appliance circuits, or non-addressable signaling line circuits of a control unit; one for each incoming and one for each outgoing wire. It is not prohibited that a common terminal be used in lieu of duplicate terminals when it is intended to prevent the looping of an unbroken wire around or under a terminal screw in a manner that permits the looped wire to remain unbroken during installation, thereby precluding supervision in the event the wire becomes dislodged from under the terminal. A notched clamping plate under a single securing screw, where separate conductors are intended to be inserted in each notch, is an equivalent arrangement.

17.1.4 There shall be adequate space within a terminal or wiring compartment to permit the use of a standard conduit bushing when a bushing is required for installation.

17.1.5 The field-wiring compartment area of a product to which connections are to be made is to be of sufficient size for completing all wiring connections as specified by the installation wiring diagram.

17.1.6 The wiring terminals of a product intended for mounting in an outlet or junction type box shall be located or protected so that, upon installation:

a) The wiring in the outlet box is not forced against the product, product's terminals, or sharp edges so as to damage the conductor insulation or product's unprotected components; and/or

b) A product with exposed wiring terminals shall be held in its intended mounting location inside the box by mechanical means.

17.2 Field-wiring terminals (general application)

17.2.1 As specified in these requirements, field-wiring terminals are those terminals to which power, signal, or communication circuits (including equipment grounding) will be made in the field when the product is installed as intended.

17.2.2 A field-wiring terminal shall comply with the requirements in:

a) 17.2.4 – 17.2.7;

b) The field wiring requirements in the Standard for Electrical Quick-Connect Terminals, UL 310;

c) The Standard for Wire Connectors, UL 486A-486B;

d) The Standard for Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors, UL 486E; or

e) The Standard for Terminal Blocks, UL 1059, rated for field-wiring (FW) Code 2 applications and also suitable for the voltage, current, wire range, and wire type of the intended application.

The current-carrying parts shall be silver, copper, a copper alloy, or a similar nonferrous conductive material. Securing screws and the like may be plated steel. Equipment provided with quick-connect terminals intended for field termination of electrical conductors to the equipment and complying with the Standard for Electrical Quick-Connect Terminals, UL 310, shall be provided with strain relief, and the installation instructions shall include instructions for effecting the strain relief and include reference to the specific connectors to be used.

Exception: In the case where power is supplied to the burglar alarm unit from a power over communications cable source that has been tested and is in compliance with Section 36, then the minimum permissible field wiring wire size to be used shall not be less than 26 AWG for patch cords; 24 AWG for horizontal or riser cable.

17.2.3 A field-wiring terminal shall be prevented from turning or shifting in position. This may be accomplished by means, such as two screws or rivets; by square shoulders or mortises; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part. Friction between surfaces is not acceptable for preventing movement of the terminals.

17.2.4 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for 10 AWG (5.3 mm^2) and larger wires. When the connectors or lugs are secured to a plate, the plate thickness shall not be less than 0.050 inch (1.3 mm) thick. Securing screws may be plated steel.

17.2.5 A wire binding screw used at a wiring terminal shall not be smaller than No. 8 (4.2 mm diameter). Plated screws are not prohibited.

Exception: A No. 6 (3.5 mm diameter) screw may be used for the connection of one 14 AWG (2.1 mm^2) or smaller conductor and a No. 4 (2.8 mm diameter) screw may be used for the connection of one 19 AWG (0.65 mm^2) or smaller conductor.

17.2.6 Terminal plates tapped for wire binding screws shall:

a) Have not less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or the equivalent, to hold the wires in position. Other constructions may be employed if they provide equivalent thread security of the wire binding screw. However, two full threads are not required if fewer threads will result in a secure connection in which the threads will not strip with tightening torque in accordance with the values indicated in the Standard for Wire Connectors, UL 486A-486B.

b) Be of a nonferrous metal not less than 0.050 inch (1.3 mm) thick when used with a No. 8 (4.2 mm diameter) or larger screw, and not less than 0.030 inch (0.76 mm) thick if used with a No. 6 (3.5 mm diameter) or smaller screw.

17.2.7 When two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be employed for each additional conductor. A separator washer is not required when two conductors are separated and intended to be secured under a common clamping plate. When the wires protrude above terminal barriers, the nonferrous separator shall include means, such as upturned tabs or sides, to retain the wire.

17.3 Field-wiring terminals (qualified application)

17.3.1 Any of the following terminal configurations may be employed for connection of field wiring when they comply with all of the requirements in 17.3.2.

a) Telephone Type Terminals – Nonferrous terminal plates using a narrow V-shaped slot for securing of a conductor in a special post design. Requires special tool for wire connection;

b) Solderless Wrapped Terminals – Solderless wrapped nonferrous terminals which require a special tool and terminal post design;

c) Quick-Connect Terminals – Nonferrous quick-connect (push type) terminals consisting of male posts permanently secured to the device and provided with compatible female connectors for connection to field wiring. These require a special tool for crimping of field wires. Mating terminals shall be shipped with the product with instructions for their installation;

d) Push-In Terminals – Nonferrous (screwless) push-in terminals of the type used on some switches and receptacles wherein solid conductors may be pushed into slots containing spring-type remaining contacts. The leads can be removed by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals are not acceptable for use with aluminum conductors. The marking adjacent to the terminal shall indicate that copper conductors only are to be used;

e) Solder Terminals – Conventional nonferrous solder terminals;

f) Communication Terminals – For Ethernet, USB, FireWire (IEEE 1394), and the like data transmission, employing connectors complying with the requirements of the Standard for Communications-Circuit Accessories, UL 1863, or the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977;

Exception: In the case where power is supplied to the burglar alarm unit from a power over communications cable source that has been tested and is in compliance with Section 36, then the field wiring terminal shall typically be an RJ-45 style jack that complies with the requirements of the Standard for Communications-Circuit Accessories, UL 1863.

g) Other Terminals – Other terminal connections may be employed if found to be equivalent to (a) – (f) and limited to the same restrictions.

17.3.2 Any of the terminal configurations listed in 17.3.1 may be employed for connection of field wiring when there is compliance with all of the following:

a) When a special tool is required for connection, its use shall be indicated on the installation wiring diagram and the name of its manufacturer and its model number or equivalent shall also be indicated, along with information as to where the tool may be obtained.

b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size shall not be smaller than 26 AWG (0.13 mm^2).

c) The wire size to be employed shall have the current-carrying capacity for the circuit application.

d) The terminal configuration shall comply with the requirements in the Special Terminal Assemblies Tests, Section 68.

Exception: Terminals complying with the requirements in any of the standards specified in 17.2.2 (b) – (e) are not required to be subjected to the Special Terminal Assemblies Tests, Section 68.

17.4 Field-wiring leads

17.4.1 Leads provided for field and/or splice connections to a low-voltage power-limited circuit shall not be less than 6 inches (152 mm) long, shall not be smaller than 22 AWG (0.32 mm^2), and shall be a minimum of 1/64 in. (0.4 mm) thick.

Exception No. 1: A lead may be less than 6 inches long if it is evident that the use of a longer lead may result in damage to the lead insulation or product, or result in a risk of fire, electric shock, or injury to persons, or is not required for the intended operation of the product.

Exception No. 2: Copper leads as small as 26 AWG (0.13 mm^2) may be used if:

a) The current does not exceed 1 ampere for lengths up to 2 feet (61 cm) and the current does not exceed 0.4 ampere for lengths up to 10 feet (3.05 m);

b) There are two or more conductors and they are covered by a common jacket or the equivalent;

c) The assembled conductors comply with the requirement of 62.2 for strain relief; and

d) The installation instructions indicate that the lead shall not be spliced to a conductor larger than 18 AWG (0.82 mm^2).

Exception No. 3: In the case where power is supplied to the burglar alarm unit from a power over communications cable source that has been tested and is in compliance with Section 36, then the minimum permissible field wiring wire size to be used shall not be less than 26 AWG for patch cords; 24 AWG for horizontal or riser cable.

17.4.2 Leads intended for connection to a high voltage circuit shall not be less than 6 inches (152 mm) long and shall not be smaller than 18 AWG (0.82 mm^2). The insulation, when of rubber or thermoplastic, shall be a minimum 0.30 inch (0.76 mm) minimum average and 0.027 inch (0.69 mm) minimum at any point.

17.4.3 All leads intended for connection to an external circuit shall comply with the Strain Relief Test of Section 65.

17.5 Power-limited circuits

17.5.1 When the design of the product is such that the product either requires or permits power-limited circuit conductors to occupy the same enclosure as electric light, power, Class 1, or non-power-limited fire-protective signaling-circuit conductors, or medium-power network-powered broadband communications-circuit conductors, both of the conditions in (a) and (b) shall be met:

a) The enclosure shall provide one or more cable openings into the enclosure. When a single opening is provided, a continuous and firmly fixed nonconductor, such as flexible tubing, shall be provided. This is required so that the power-limited conductors are segregated from electric light, power, Class 1 conductors, non-power-limited fire-protective signaling conductors, and medium-power network-powered broadband communications-circuit conductors. The installation document of the product shall completely detail cable entry routing of all conductors into the product;

b) The product shall be constructed so that, with all field-installed wiring connected to the product, either:

1) A minimum 1/4 inch (6.4 mm) is provided between all power-limited conductors and all electric light, power, Class 1 conductors, non-power-limited fire-protective signaling conductors, or medium-power network-powered broadband communications-circuit conductors; or

2) For circuit conductors operating at 150 V or less to ground where the power-limited conductors are installed using Types FPL, FPLR, FPLP, or equivalent cables, a minimum 1/4 inch (6.4 mm) separation is provided between these power-limited cable conductors extending beyond the jacket and all electric light, power, Class 1 conductors, non-power-limited fire-protective signaling conductors, and medium-power network-powered broadband communications-circuit conductors.

17.5.2 Compliance with the requirements in 17.5.1 shall be achieved by specific wire routing configurations that are detailed in the installation document, or when a wire routing scheme will not maintain the required separation, barriers, or nonconductive sleeving shall be used to provide separation. See also 89.3.

17.6 Communication circuits

17.6.1 Where a product has provisions for connection to communication circuits that use outside wiring as covered by Article 800 in the National Electrical Code, ANSI/NFPA 70, the product shall comply with the requirements for protection against overvoltage from power line crosses described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

18 Grounding

18.1 A grounding means shall be provided for all equipment containing high voltage circuits and/or any other parts that require grounding.

18.2 The following are considered to constitute means for grounding:

a) In a product intended to be permanently connected by a metal enclosed wiring system, a knockout or equivalent opening in the metal enclosure of the product for the connection of metal-clad cable, conduit, metal raceway, or the like.

b) In a product intended to be permanently connected by a nonmetallic enclosed wiring system, such as nonmetallic-sheathed cable, an equipment grounding terminal or lead.

c) In a cord-connected product, an equipment grounding conductor in the cord.

18.3 On a permanently-connected product, a terminal intended solely for the connection of an equipment grounding conductor shall be capable of securing a conductor of the size rated for the application in accordance with the National Electrical Code, ANSI/NFPA 70.

18.4 A soldering lug, a push-in terminal, a screwless connector, or a quick-connect or similar friction fit connector shall not be used for the grounding terminal intended for the connection of field supply connections or for the grounding wire in a supply cord.

18.5 On a permanently-connected product, a wire-binding screw or a pressure wire connector intended for the connection of an equipment-grounding conductor shall have one of the following:

a) A green-colored head that is hexagonal, slotted, or both;

b) A plainly identified marking of "G," "GR," “GND”, "Ground," or "Grounding," or the like;

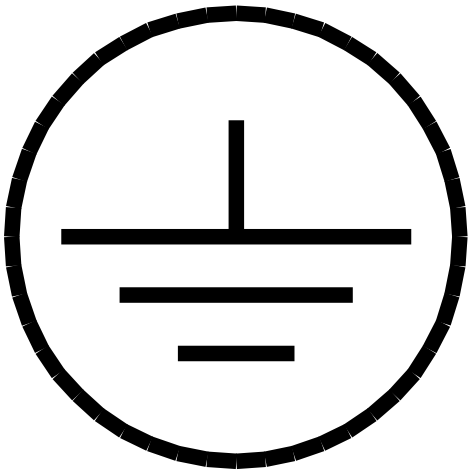
c) A marking with the Symbol 5019 graphic from IEC Publication 60417-1 shown in Figure 18.1; or

d) A marking on a wiring diagram provided on the product.

The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the product and shall be located so that it is unlikely to be removed during service operations, such as replacing fuses, resetting manual-reset devices, or the like.

Figure 18.1

International Electrical Symbol



18.6 If a pressure wire connector intended for grounding is located where it could be mistaken for a neutral conductor of a grounded supply, it shall be identified by a marking "EQUIPMENT GROUND" or with a green color identification or both.

18.7 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size specified in Table 18.1.

Table 18.1
Bonding Wire Conductor Size

Rating of overcurrent device, amperes	Size of bonding conductor[a]			
	Copper wire,		Aluminum wire,	
	AWG	(mm^2)	AWG	(mm^2)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)
200	6	(13.3)	4	(21.2)

[a] Or equivalent cross-sectional area.

18.8 On a permanently-connected product, the surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

18.9 On a cord-connected product, the grounding conductor of the flexible cord shall be green with or without one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the product by a positive means (see 18.18), that is not likely to be removed during any servicing operation not involving the power supply cord. The grounding conductor shall be connected to the grounding blade or terminal of the attachment plug.

18.10 When a product is provided with means for separate connection to more than one power supply, each such connection shall be provided with a means for grounding.

18.11 In a product intended for connection to a high-voltage source, provision shall be made for the grounding of all exposed or accessible noncurrent-carrying dead metal parts that are might become energized and that may be contacted by the operator, user, or by service personnel during service operations likely to be performed while the product is energized.

18.12 Uninsulated metal parts, such as cabinets, electrical enclosures, capacitors, and other electrical components, shall be bonded for grounding if they may be contacted by the operator or serviceperson, except as indicated in 18.13.

18.13 Metal parts described as follows need not be grounded:

a) Adhesive-attached metal-foil markings, screws, handles, and the like, which are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized.

b) Isolated metal parts, such as small assembly screws, etc., which are positively separated from wiring and uninsulated live parts.

c) Cabinets, panels, and covers that do not enclose uninsulated live parts when wiring is positively separated from the cabinet, panel, or cover so that they are not likely to become energized.

d) Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material that is a minimum of 1/32 inch (0.8 mm) thick, and secured in place.

18.14 All dead-metal parts that are accessible during intended use or user servicing, and that are capable of becoming energized from circuits involving a risk of electric shock, shall be connected together and to the grounding means.

Exception: Not applicable for metal parts as described in 18.13.

18.15 The metal enclosure of a product having a slide-out chassis is considered to be grounded if the resistance between the point of connection of the equipment grounding means and enclosure does not exceed 0.1 ohm. Unless a separate grounding conductor is used, this will require that all nonconductive coatings between the enclosure and equipment grounding means be penetrated when the chassis is inserted in the enclosure. In such cases, metal-to-metal contact must be maintained at any point of insertion or withdrawal of the chassis.

18.16 Metal-to-metal hinge bearing members for a door or cover are considered to meet the requirement for bonding a door or cover for grounding if:

a) A minimum of two pin-type hinges are employed, each with a minimum of three knuckles; or

b) The hinges are continuous (piano-type).

18.17 A separate component-bonding conductor shall be of copper, a copper alloy, or other material acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings, such as enameling, galvanizing, or plating. A separate bonding conductor or strap shall:

a) Be protected from mechanical damage or be located within the confines of the outer enclosure or frame; and

b) Not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

18.18 The bonding shall be by a positive means, such as by clamping, riveting, brazing, welding, or by bolted or screwed connection. The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. Bonding around a resilient mount shall not rely on the clamping action of rubber or other nonmetallic material.

18.19 With reference to 18.18, a bolted or screwed connection that incorporates a star washer or serrations under the screw head, is acceptable for penetrating nonconductive coatings. Where the bonding means depends upon screw threads, the use of two or more screws or two full threads of a single screw engaging the metal is in compliance with 18.18.

18.20 On a cord-connected product, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord. See also 18.23 and 18.25.

18.21 On a permanently-connected product, the size of a conductor employed to bond an electrical enclosure shall be based on the rating of the branch-circuit overcurrent device to which the equipment will be protected. The size of the conductor or strap shall be in accordance with Table 18.1. An equipment grounding conductor is not required to be larger than the circuit conductors supplying the equipment.

18.22 A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in 18.21, is acceptable if the minimum cross-sectional conducting area is equivalent to the wire sizes specified in Table 18.1.

18.23 A bonding conductor to an electrical component need not be larger than the size of the conductors supplying the component.

18.24 Splices shall not be employed in wire conductors used to bond electrical enclosures or other electrical components.

18.25 If more than one size branch circuit overcurrent protective device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a component is individually protected by a branch circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding conductor for that component is sized on the basis of the overcurrent device intended for ground-fault protection of the component.

18.26 The continuity of the grounding system of the product shall not rely on the dimensional integrity of nonmetallic material.

18.27 When a means for grounding is provided on the product, even though it is not required, it shall comply with the requirements in 18.1 – 18.26.

INTERNAL WIRING

19 General

19.1 The wiring and connections between parts of a product shall be protected or enclosed, or they shall be in a cord or cable that has been evaluated and determined to be rated for the application.

19.2 Internal wiring shall have thermoplastic or rubber insulation not less than 1/64 inch (0.4 mm) thick for 0 – 300 volt applications if power is less than 375 volt-amperes, current is less than 5 amperes, and the wiring is not subject to flexing or mechanical abuse. Otherwise, thermoplastic or rubber insulation not less than 1/32 inch (0.8 mm) thick and rated 600 volts, or appropriately rated supplementary insulation applied to the internal wiring, shall be used.

19.3 Leads or a cable assembly, connected to parts mounted on a hinged cover, shall be of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged to reduce the risk of abrasion of insulation and jamming between parts of the enclosure.

19.4 Insulation, such as coated fabric and extruded tubing, shall not physically or electrically deteriorate as a result of exposure to the temperature or other environmental conditions to which it may be subjected in intended use.

19.5 Internal wiring shall be evaluated and determined to be rated for the application, with respect to temperature, voltage, ampacity, and exposure to oil, grease, solvents, acids, and other conditions of service to which the wiring is subjected.

19.6 When it is possible that internal wiring is to be exposed to moisture, including any condensation resulting from operation of the product, the wiring shall be evaluated and determined to be rated for such exposure. See Outdoor Use Equipment, Sections 71 – 82.

19.7 Vibration, impact, flexing, or other movement of wires during intended use, including user servicing, shall not reduce the wire insulation or the wire termination integrity.

19.8 Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, and the like, that may cause abrasion of the conductor insulation. Holes in sheet metal walls through which insulated wires pass shall be provided with a bushing if the wall is 0.042 inch (1.07 mm) or less in thickness. Holes in walls thicker than 0.042 inch shall have smooth, rounded edges.

20 Wiring Methods

20.1 All splices and connections shall be mechanically secure and electrically bonded. Consideration shall be given to vibration when investigating electrical connections. Pressure-wire connectors have been determined to comply with the requirements.

20.2 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or equivalently arranged.

20.3 A splice shall be provided with insulation equivalent to that of the wires involved.

20.4 In determining whether or not splice insulation consisting of coated-fabric, thermoplastic, or another type of tape or tubing complies with the aforementioned requirements, a comparison is to be made of factors such as mechanical strength, dielectric properties, and heat- and moisture-resistant characteristics. Thermoplastic tape wrapped over sharp edges does not comply with the intent of this requirement.

20.5 When stranded internal wiring is connected to a wire-binding screw, there shall not be loose strands of wire that contact other uninsulated live parts or dead-metal parts. This shall be accomplished by use of pressure-terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other means that have been determined to be equivalent.

20.6 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent which shall provide a smooth, rounded surface against which the cord may bear.

20.7 If the cord hole is in phenolic composition or other nonconducting material, or in metal not less than 0.042 inch (1.07 mm) thick, a smooth, rounded surface is considered to be the equivalent of a bushing.

20.8 Ceramic materials and some molded compositions may be used for insulating bushings if they have been investigated and found acceptable for the purpose.

20.9 Fiber may be employed where it will not be subjected to temperatures higher than 90 °C (194 °F) under intended operating conditions if the bushing is not less than 3/64 inch (1.2 mm) thick and if it will not be exposed to moisture.

20.10 A soft rubber bushing may be employed in the frame of a motor if the bushing is not less than 3/64 inch (1.2 mm) thick and if the bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substance which may have a deleterious effect on rubber. If a soft rubber bushing is employed in a hole in metal, the hole shall be free from sharp edges, burrs, projections, and the like, which would be likely to cut into the rubber.

20.11 An insulating-metal grommet is acceptable in lieu of an insulating bushing, when the insulating material used is not less than 1/32 inch (0.8 mm) thick and completely fills the space between the grommet and the metal in which it is mounted.

21 Separation of Circuits

21.1 Internal wiring of circuits that operate at different potentials shall be separated by barriers, clamps, routing, or other equivalent means, unless all conductors are provided with insulation that is rated for the highest voltage involved. Also see 17.5, Power-limited circuits, for separation of circuits criteria for product wiring.

21.2 A barrier used to provide separation between the wiring of different circuits shall be of metal or of insulating material. A barrier of insulating material shall not be less than 0.028 inch (0.71 mm) thick. Any clearance between the edge of a barrier and a compartment wall shall not be more than 1/16 inch (1.6 mm).

COMPONENTS, ELECTRICAL

22 General

22.1 Mounting of components

22.1.1 All parts of a product shall be mounted in position and prevented from loosening or turning when such motion may adversely affect the performance of the product, or may increase the risk of fire, electric shock, and/or injury to persons incident to the operation of the product.

22.1.2 A switch, lampholder, attachment-plug, connector base, or similar electrical component shall be secured in position and, except as noted in the following paragraphs, shall be prevented from turning.

22.1.3 The requirement that a switch be prevented from turning may be waived if all of the following conditions are met:

a) The switch is a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during intended operation of the switch;

b) The means for mounting the switch makes it unlikely that the operation of the switch will loosen it;

c) Spacings are not reduced below the minimum required values if the switch rotates; and

d) The operation of the switch is by mechanical means rather than by direct contact by persons.

22.1.4 A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation will not reduce spacings below the minimum required values.

22.1.5 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position, if such motion may result in a reduction of spacings below the acceptable values. (Securing of contact assemblies shall provide for the continued alignment of contacts.)

22.1.6 The means for preventing turning shall not consist only of friction between surfaces.

22.1.7 A lock washer which provides both spring take-up and an interference lock is acceptable as the means for preventing from turning a small stem-mounted switch or other device having a single-hole mounting means.

22.1.8 A rotating part that by loosening presents a risk of fire, electric shock, electrical-energy/high-current levels, or injury to persons, shall be assembled so that the direction of rotation tends to tighten the means that hold the rotating part in place.

Exception: A keyed part, a press fit, a part locked in place with a pin, or means that have been determined to be equivalent, can be used to hold a rotating part in place.

22.1.9 A flush plate for outlet-box mounting shall be of 0.030 inch (0.76 mm) or thicker ferrous metal, of 0.040 inch (1.02 mm) or thicker nonferrous metal, or of 0.100 inch (2.54 mm) or thicker nonconductive material.

22.1.10 A yoke, strap, or the mounting ears of a part intended to be mounted on a standard outlet box or similar back box shall be of 0.040 inch (1.02 mm) or thicker steel. If a nonferrous metal is used, it shall be of thickness sufficient to provide mechanical strength and rigidity equivalent to that of 0.040 inch thick steel.

22.1.11 All subassemblies, modules, and printed-wiring boards shall be held in their intended place in the product by mechanical means.

22.2 Insulating materials

22.2.1 Insulating materials used as a base for the direct or indirect support of live parts involving risk of fire, electric shock, or electrical-energy/high-current levels shall be of a flame-resistant, moisture-resistant insulating material, such as porcelain, phenolic or cold-molded composition, or the equivalent and shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

22.2.2 A base mounted on a metal surface shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base which are not staked, upset, sealed, or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

22.2.3 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not for the sole support of live parts where shrinkage, current leakage, or warping of the fiber may introduce a risk of fire or electric shock.

22.2.4 Molded parts shall have the mechanical strength and rigidity to withstand the stresses of actual service.

22.2.5 A countersunk sealed live part shall be covered with a waterproof insulating compound that will not melt at a temperature 15 °C (59 °F) higher than the maximum intended operating temperature of the assembly, and at not less than 65 °C (149 °F) in any case. The depth or thickness of sealing compound shall not be less than 1/8 inch (3.2 mm).

22.2.6 An insulating liner shall be investigated and determined to be rated for the purpose. Barriers shall be held in place by a means more secure than friction between surfaces. The elasticity of tubing shall not be depended upon to hold the tubing in place. Heat-shrink tubing has been determined to meet this requirement where a sharp edge or point is not involved.

22.2.7 The thickness of a flat sheet of insulating material, such as phenolic composition or the equivalent, used for panel-mounting of parts shall not be less than that indicated in Table 22.1.

Table 22.1
Thickness of Flat Sheets of Insulating Material

Maximum dimensions				Minimum thickness,[a]	
Length or width,		Area,			
inch	(cm)	inch^2	(cm^2)	inch	(mm)
24	(60.9)	360	(2322)	3/8	(9.5)
48	(122.0)	1152	(7432)	1/2	(12.7)
48	(122.0)	1728	(11148)	5/8	(15.9)
Over 48	(122.0)	Over 1728	(11148)	3/4	(19.1)

[a] Material less than 3/8 inch (9.5 mm) but not less than 1/8 inch (3.2 mm) in thickness may be employed for a panel if the panel is supported or reinforced to provide rigidity not less than that of a 3/8 inch sheet. Material less than 1/8 inch (3.2 mm) may be employed for subassemblies, such as supports for terminals for internal wiring, resistors, and other components.

22.3 Current-carrying parts

22.3.1 All current-carrying parts shall be of silver, copper, a copper alloy, stainless steel, aluminum, or other material recognized as acceptable for use as an electrical conductor.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not comply with this requirement.

22.3.2 Bearings, hinges, and the like, are not acceptable for use as current-carrying parts.

23 Protective Devices

23.1 A fuseholder, overcurrent protective device (other than an automatic control without a marked off position), the center contact of a screwshell-base lampholder, an interlock, and a manual on-off switch with a marked off position, shall be connected to the ungrounded side of the line when used in a high-voltage circuit.

23.2 A fuseholder shall be of either the cartridge-enclosed or plug-fuse type. The use of plug fuses is to be limited to equipment rated at not more than 125 or 125/250 V.

23.3 Fuseholders, fuses, and circuit breakers shall be rated for the application and must comply with the applicable requirements for the component (see Appendix A).

23.4 A fuseholder shall be installed or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. A separation of less than 6 inches (152 mm) is considered to be adjacent. See Trained Service Personnel, 10.2.

23.5 A fuse or circuit breaker provided in the output of a power supply shall comply with the requirements noted in the Power-Limited Circuits Test, Section 45.

23.6 A fuse or other overcurrent protective device provided in the supply circuit of a power supply shall have a rating not greater than 150 percent of the input rating of the power supply unit.

23.7 All external circuits intended to be connected to nonpower-limited wire shall contain either current-limiting or overcurrent protection to prevent fault currents in excess of the current rating for the gauge wire size permitted by the National Electrical Code, ANSI/NFPA 70, or as specified in the installation wiring diagram/instructions.

24 Printed-Wiring Boards

24.1 Printed-wiring boards shall be suitable for the application and shall comply with the requirements in the Standard for Printed Wiring Boards, UL 796. The securing of components to the board shall be made in the intended manner and the spacings between circuits shall comply with the requirements for Spacings, General, Section 33. The board shall be reliably mounted so that deflection of the board during installation or servicing shall not result in damage to the board or in developing a risk of fire or electric shock.

24.2 All printed-wiring boards shall have a minimum flammability rating of V-2, rated for direct support of current-carrying parts, and be suitable for the soldering process used.

24.3 A printed wiring assembly employing insulating coatings or encapsulation shall comply with the requirements of the Dielectric Voltage-Withstand Test, Section 55, before and after being treated. If it is impractical to use untreated samples, finished samples shall comply with the requirements of the Dielectric Voltage-Withstand Test, after they are subjected to the Humidity Test, Section 49, the Temperature Test, Section 56, and other applicable tests in this standard.

24.4 Any conformal coating or laminate used on a printed-wiring board shall comply with the Standard for Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E.

25 Transformers and Coils

25.1 Relays, transformers, and similar devices used in high-voltage circuits shall be evaluated and rated for the intended purpose, or comply with the applicable requirements for the component (see Appendix A).

25.2 A transformer shall be of the two-coil or insulated type.

Exception: An autotransformer may be employed, when the terminal or lead common to both input and output circuits is identified as being intended for connection to the grounded conductor, and the output circuits are located only within the enclosure containing the autotransformer.

25.3 Coils shall be treated with an insulating varnish, or the equivalent, and baked or otherwise impregnated to exclude moisture.

25.4 Film-coated or equivalently coated wire is not required to be given additional treatment to reduce the risk of moisture absorption.

26 Semiconductors

26.1 Semiconductors shall be rated for the intended application under all environmental conditions to which they may be exposed in service, and must comply with the applicable requirements for the component (see Appendix A). See Performance Tests, Sections 35 – 82.

27 Across-the-Line Components

27.1 Components such as capacitors and EMI filters, connected across the high-voltage supply circuit of a product, shall be rated for the purpose and must comply with the applicable requirements for the component (see Appendix A).

27.2 A component is considered to be across the high-voltage supply circuit when, in a shorted condition, a current of more than 1 amp passes through it when the product is in any condition where the

individual components have reached ultimate operating temperatures. The current through the component can be limited to 1 amp or less by a fixed impedance or a protective device rated 1 amp or less.

27.3 A capacitor is also considered to be across-the-line when it is used under either of the following conditions:

a) For high-voltage supply-line bypass in equipment provided with a terminal or connection intended to be grounded; or

b) For antenna blocking or high-voltage supply-line bypass in equipment provided with one or more external antenna terminals that may be grounded.

28 Capacitors

28.1 The intended operation of a capacitor shall not be impaired by the temperature to which it may be subjected under the most severe conditions of intended use. See the Temperature Test, Section 56.

29 Voltage-Dropping Resistors

29.1 A carbon composition resistor shall not be used as a line voltage-dropping resistor in the high-voltage supply circuit of a product.

30 Switches

30.1 A switch provided as part of the product shall have a current and voltage rating not less than that of the circuit which it controls when the device is operated under any condition of intended service.

31 End-of-Line Devices

31.1 An end-of-line device shall be constructed as follows:

a) Where the circuit in which the end-of-line device is to be connected is intended for connection by conduit or metal-clad cable, the device shall be arranged for mounting inside of a metal box to which such connection can be made. Mounting on an outlet box cover with terminals or leads provided for field connection, or an equivalent arrangement, has been determined as complying with the intent of this requirement.

b) Where the end-of-line device is intended to be installed inside a backbox, splice leads, or terminals suitable for making field connections, shall be provided. Splice leads shall have a diameter of not less than 18 AWG (0.82 mm^2). The exposed live parts of the assembly, except for the connection portion of the terminal, shall be covered with insulating tubing or the equivalent.

c) Where the end-of-line device is intended to be installed inside a product, such as a burglar alarm control unit or accessory:

1) Splice leads or terminals suitable for making field connections shall be provided. Splice leads shall have a diameter not less than 18 AWG. The exposed live parts of the assembly, except for the connection portion of the terminal, shall be covered with insulating tubing or the equivalent; or

2) It shall be provided with terminations compatible with the product's provisions for field wiring connections. When installed per the manufacturer's installation instructions, it shall be securely fastened with no means to open circuit, short to an adjacent circuit node, or cause a risk of electric shock. To avoid damage to the body of the end-of-line device during installation, the device shall be either supplied pre-formed or forming instructions shall be included in the installation instructions.

32 Batteries

32.1 Rechargeable (secondary) batteries

32.1.1 A storage battery shall have sealed cells, or cells with spray trap vents, and shall be maintained in the charged state.

32.1.2 Batteries shall be located and mounted so that terminals of cells are prevented from coming into contact with terminals of adjacent cells or with metal parts of the battery enclosure as a result of shifting of the batteries.

32.1.3 The mounting arrangement for the batteries shall permit access to the cells for testing and maintenance, or the product shall provide integral meters or readily accessible terminal facilities for the connection of meters for determining battery voltage and charging current.

32.1.4 A conditioning charge shall be limited so that, with the maximum rate of charge that can be obtained, the battery gases do not adversely affect any part of the product. The trickle and fast charge rates of a battery shall not exceed the battery manufacturer's recommended rates.

32.1.5 The battery shall be protected against excessive loading or charging current by a fuse or other overcurrent protective device rated at no less than 130 nor more than 200 percent of the maximum operating load on the battery, or shall comply with the low-voltage power-limited requirements as defined in 6.19(c).

32.2 Nonrechargeable (primary) dry-cell batteries

32.2.1 When a battery or set of batteries is used as the main source, or the non-rechargeable standby source of power of a product, it shall meet the requirements for Nonrechargeable (Primary) Batteries – 57.3.

32.2.2 Batteries shall be located and mounted to reduce the risk of terminals of cells coming in contact with uninsulated live parts, terminals or adjacent cells, or metal parts of the enclosure as a result of shifting.

32.2.3 Ready access shall be available to the battery compartment to facilitate battery replacement, without damage to the product components or disassembly of any part of the product, except for a cover or similar parts.

32.2.4 Removal of the product from a mounting support to replace a battery shall be permitted only where the connected wiring is not subjected to flexing or stress and the mounting of the product is supervised.

32.2.5 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs), and strain relief provided for any leads.

32.2.6 Connections to battery terminals shall be either by a lead terminating in a positive snap-action type clip, a fixed butt-type connection, or another connection means that has been determined to be equivalent. The connection shall consist of an unplated or plated metal that is resistant to the corrosive action of the electrolyte.

32.2.7 Each lead of a clip lead assembly used as part of a battery operated product shall be suited for the intended application, shall be minimum 26 AWG (0.13 mm^2) stranded wire size with minimum 1/64 inch (0.4 mm) insulation and provided with strain relief.

32.3 Lithium batteries

32.3.1 Lithium batteries shall comply with the requirements in the Standard for Lithium Batteries, UL 1642.

32.3.2 A lithium battery shall be protected from abnormal charging currents during use as required in the Standard for Lithium Batteries, UL 1642.

Exception: A circuit that obtains power solely from a lithium battery (for example, a circuit in which the lithium battery serves as the sole power source as opposed to serving as a standby power source) is not required to be subjected to the abnormal charging current requirements in Standard for Lithium Batteries, UL 1642.

SPACINGS

33 General

33.1 Except as specified in 34.1, spacings between uninsulated live parts or between uninsulated live parts and dead-metal parts shall not be less than those indicated in 33.2 – 33.6.

33.2 Where deformation of the enclosure is likely to reduce spacings, the spacings between an uninsulated live part and:

a) A wall or cover of a metal enclosure;

b) A fitting for conduit or metal-clad cable; and

c) A metal piece attached to a metal enclosure,

shall not be less than those indicated in Table 33.1. Also see Figure 33.1.

Table 33.1
Minimum Spacings

Point of application	Minimum spacings[b, c]				
	Voltage range[a]	Through air,		Over surface,	
	volts	inches	(mm)	inches	(mm)
To walls of enclosure:					
Cast metal enclosures	0 – 300	1/4	(6.4)	1/4	(6.4)
Sheet metal enclosures	0 – 50	1/4	(6.4)	1/4	(6.4)
	51 – 300	1/2	(12.7)	1/2	(12.7)
Installation wiring terminals:					
With barriers	0 – 30	1/8	(3.2)	3/16	(4.8)
	31 – 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)
Installation wiring terminals:					
Without barriers	0 – 30	3/16	(4.8)	3/16	(4.8)
	31 – 150	1/4	(6.4)	1/4	(6.4)

Table 33.1 Continued on Next Page

Table 33.1 Continued

Point of application	Minimum spacings[b, c]				
	Voltage range[a] volts	Through air, inches	(mm)	Over surface, inches	(mm)
	151 – 300	1/4	(6.4)	3/8	(9.5)
Rigidly clamped assemblies[d]					
Class 2, Power-Limited	0 – 30	–	–	–	–
Class 2, Power-Limited	Over 30	3/64	(1.2)	3/64	(1.2)
Non Class 2, Power-Limited	0 – 30	3/64	(1.2)	3/64	(1.2)
	31 – 150	1/16	(1.6)	1/16	(1.6)
	151 – 300	3/32	(2.4)	3/32	(2.4)
Other parts	0 – 30	1/16	(1.6)	1/8	(3.2)
	31 – 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)

[a] These are sine wave alternating current rms values. Equivalent direct current or peak voltages = 42.4 volts for 30 volts in the table, 70.7 volts for 50 volts in the table, 212 volts for 150 volts in the table, and 424 volts for 300 volts in the table.

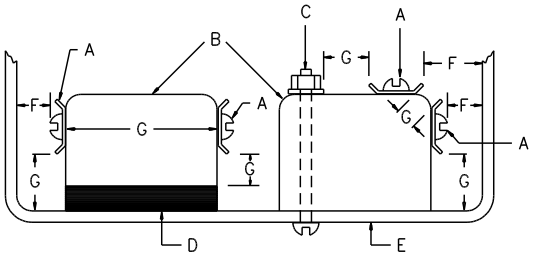
[b] An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material used where spacings would otherwise be insufficient, shall not be less than 0.028 inch (0.71 mm) thick; except that a liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through-air spacing required. The liner shall be located so that it will not be affected adversely by arcing. Insulating material having a thickness less than that specified may be used if it is suitable for the particular application.

[c] Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. The wire shall not be smaller than 18 AWG (0.82 mm^2).

[d] Rigidly clamped assemblies include such parts as contact springs on relays or cam switches, printed wiring boards, and the like.

Figure 33.1

Component Spacings



SM100

A – Uninsulated live parts of a component.

B – Insulating material of a component.

C – Mounting screw of a component.

D – Dead metal part of a component.

E – Dead metal parts of the product.

F – Spacings to which the requirements of this standard apply unless specifically noted otherwise.

G – Spacings to which the requirements of this standard may not apply.

33.3 The spacings between an uninsulated live part and:

a) An uninsulated live part of opposite polarity;

b) An uninsulated grounded dead-metal part other than the enclosure; and

c) An exposed dead-metal part that is isolated (insulated),

shall not be less than those indicated in Table 33.1. See 34.1 – 34.4 for exceptions to this requirement.

33.4 The through-air and over-surface spacings at an individual component part are to be determined on the basis of the volt-amperes used and controlled by the individual component. The spacing from one component to another, however, and from any component to the enclosure or to other uninsulated dead metal parts, shall be determined on the basis of the maximum voltage and total volt-ampere rating of all components in the enclosure.

33.5 If a short circuit between uninsulated live parts of the same polarity would prevent the intended operation of the product without simultaneously producing an alarm or trouble signal, the spacings between the uninsulated live parts shall not be less than those indicated for "Other parts" in Table 33.1.

33.6 Film-coated wire is considered an uninsulated live part in determining compliance of a product with the spacing requirements, but film coating may be used as turn-to-turn insulation in coils.

34 Components

34.1 Where minimum values of spacings cannot be measured, such as those present on multi-layered printed wiring boards, the spacings shall be such that the circuit(s) will comply with the requirements in the Dielectric Voltage-Withstand Test, Section 55.

34.2 The spacings requirements in Table 33.1 do not apply to the inherent spacings inside motors, except at wiring terminals, or to the inherent spacings of a component which is provided as part of the control unit. Such spacings are determined on the basis of the requirements for the component. The electrical clearance resulting from the assembly of a component into the complete device, including clearances to dead metal or enclosures, shall be as specified in Table 33.1.

34.3 The "To-walls-of-enclosure" spacings indicated in Table 33.1 are not to be applied to an individual enclosure of a component part within an outer enclosure.

34.4 The spacings within snap switches and similar wiring devices supplied as part of the unit are investigated on the basis of the requirements for such devices.

PERFORMANCE

35 All Units

35.1 Specific product information

35.1.1 Products that currently meet all the requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, fulfill the following requirements: Leakage Current Test, Section 50; Electric Shock Current Test, Section 51; Dielectric Voltage-Withstand Test, Section 55; Abnormal Operation Test, Section 58; Polymeric Materials Test, Section 62; Strain Relief Test, 65.1 only; Mechanical Strength Tests for Enclosures, Section 66; and Special Terminal Assemblies Tests, Section 68.

35.1.2 In addition to 35.1.1, products that currently meet all the Limited Power Source (LPS) requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology

Equipment – Part 1: Safety Requirements, UL 62368-1, also fulfill the requirements of the Power-Limited Circuits Test, Section 45.

35.2 Test units and data

35.2.1 Burglar alarm units that are fully representative of production units are to be used for the tests described in Sections 36 – 82, unless otherwise specified.

35.2.2 The devices used for testing are to be those specified by the wiring diagram of the product, except that substitute devices may be used if they produce functions and load conditions equivalent to those obtained with the devices intended to be used with the product.

35.3 Test samples and miscellaneous data

35.3.1 The following shall be provided for testing:

a) Two or more complete burglar alarm units of each model to be tested.

Exception: A single sample may be provided if the size and complexity of the product would make it impracticable to provide more than one sample. The single sample shall be fully representative of the product/system.

b) One or more samples of each encapsulated or sealed assembly are to be provided in the unencapsulated or unsealed condition.

c) Additional samples as required by the specific test.

d) Information required for assessment (see Section 7).

35.4 Test voltages

35.4.1 Unless specifically noted otherwise, the test voltage for each test of a product shall be at the rated voltage as specified in Table 35.1.

Table 35.1
Voltage for Tests

Voltage rating of product	Test potential, volts
110 – 120	120
220 – 240	240
Other	Marked rating

OPERATION

36 Power Over Communications Cable Equipment

36.1 General

36.1.1 This section provides requirements for the evaluation of power over communications cable devices for burglar alarm systems and equipment. Power sources may be provided integral with the burglar alarm equipment or as a separate device supplying power.

36.1.2 The equipment is intended to comply with the following sections of the National Electrical Code, ANSI/NFPA 70:

a) Where the power supplied over a communications cable is less than or equal to 60 watts: Article 725.121, Power Sources for Class 2 and Class 3 Circuits;

b) Where the power supplied over a communications cable is greater than 60 watts: Article 725.144, Transmission of Power and Data.

36.1.3 The power sourcing equipment (PSE) shall comply with the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, and/or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, the requirements of this Section, as well as meet the requirements of 9.1.1, 35.1.1, 35.1.2, and all other applicable requirements of this Standard. Powered Devices (PD) shall comply with the requirements of this Section, as well as all other applicable requirements of this Standard.

36.1.4 These requirements apply to all connected equipment and interconnections necessary to ensure normal operation of the network powered burglar alarm system.

36.1.5 A power over communications circuit must be power-limited and shall not exceed 60 V DC, 8.0 amperes, and/or 100 watts. Products shall be evaluated at the marked input/output circuit ratings.

36.1.6 Equipment covered by this section that is intended to be located in an outdoor environment is subject to the requirements noted in Outdoor Use Equipment, Sections 71 – 82, as applicable. In addition, any equipment installed in outdoor applications shall employ National Electrical Code, Class 3 wiring methods.

36.2 Installation and operation

36.2.1 Communications circuits

36.2.1.1 Where a product has provisions for connection to a telephone, or outside wiring as covered by Article 800 in the National Electrical Code, NFPA 70, the product shall comply with the requirements for Protection Against Overvoltage From Power Line Crosses described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

36.2.1.2 Where the product is intended to, or under normal use conditions can come in contact with the equipment users, the product shall comply with requirements for Protection of Equipment Users From Overvoltages on Telecommunication Networks, described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

36.2.2 Location of midspan PSE or power injector

36.2.2.1 The midspan PSE or power injector can be located at any point within the defined structured cabling channel compliant to the Standard for Balanced Twisted-Pair Telecommunications Cabling and Components, ANSI/TIA-568-C.2, between the network switch and the powered device (PD).

36.2.3 Cabling requirements

36.2.3.1 Category 5e cabling is the minimum performance category recommended. The performance category utilized should match the transmission speed required at the installation site.

36.2.3.2 The minimum conductor gauge permitted to connect between the PSE or power injector and the PD shall be 26 AWG (0.13 mm^2) for patch cords; 24 AWG (0.21 mm^2) for horizontal or riser cable.

36.2.4 Additional requirements

36.2.4.1 Products that utilize power over communications cable are typically connected through standard eight-pin RJ-45 connectors. The connector configuration shall be supplied in the product documentation with the power over communications equipment.

36.2.4.2 The equipment shall be provided with information concerning the power sourcing equipment (PSE) connector configuration (for example, Alternative A or Alternative B or both), and the maximum power class supported by the PSE.

36.2.4.3 Power sourcing equipment and powered devices that meet the requirements of this standard shall specify the network powered burglar alarm system and equipment with which it is compatible with.

36.3 Markings

36.3.1 PoE equipment for burglar alarm systems that complies with the requirements of Section 45, Power-Limited Circuits Test, shall be marked to specifically identify all power-limited circuits by terminal designation. This marking may be on a separate installation wiring diagram if so referenced on the product.

36.3.2 The maximum voltage and current for each power over communications circuit shall be marked in accordance with 89.1(d).

36.3.3 In addition to “Security Equipment”, power over communications cable equipment shall be identified as "UL 60950", "UL 60950-1", "Information Technology Equipment" (or "Info. Tech. Equip." or "I.T.E."), “UL 62368”, “UL 62368-1”, or “Audio/Video, Information and Communication Technology Equipment”, as applicable.

36.4 Installation and operating instructions

36.4.1 In addition to the information noted in Section 91, the following paragraphs contain essential information that shall be provided in the product installation instructions of the power over communications cable equipment:

a) 1.9.7, IEEE statement;

b) 36.1.2, NEC statement;

c) 36.1.6, outdoor applications;

d) 36.2.1.1, outside wiring;

e) 36.2.3.1, Cat 5e cabling;

f) 36.2.3.2, min. conductor gauge; and

g) 36.2.4.1, 36.2.4.2, connector configurations.

37 Software-Based Receiving Equipment

37.1 This section describes alternate methods for the evaluation of software-based central/proprietary (monitoring) station receiving equipment meeting the conditions specified in 37.4. This section does not

apply to hardware receiving units or to equipment intended for use at the protected premises such as control units, intrusion detection units, and the like.

37.2 The software and hardware combination as indicated below is intended to serve the same function as a traditional dedicated hardware receiving unit. The software supports all of the signal-receiving, -recording, and -supervision functions necessary for the normal operation of the associated control units installed at the protected premises.

37.3 For protection against compromise, the communication channel between the protected premises and the monitoring station may be provided with Standard Line Security and/or Encrypted Line Security as indicated in 40.14 and 40.15.

37.4 Software receiving equipment meeting all the conditions specified in (a) – (p) need not be subjected to Sections 42 – 68.

a) Data processing equipment and office appliance/business equipment used as central/proprietary (monitoring) station equipment shall comply with the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

b) As noted in the product installation instructions, the manufacturer specifies the minimum receiving equipment configuration(s) consisting of the following:

1) Operating system and revision level;

2) Microprocessor manufacturer, type/family, and minimum clock speed;

3) Minimum storage requirements;

4) Minimum memory requirements;

5) Required features (such as media needs (DVD, etc.), drivers, etc.);

6) Required input/output functionality (such as serial ports, USB ports, and network cards);

7) Monitoring software revision level; and

8) Interconnection of redundant equipment including any operator interfaces, signal inputs, and outputs to automation equipment, where applicable.

c) Equipment meeting, but not exceeding the specifications of 37.4(b), shall be submitted for evaluation. In addition, compliance with the following tests shall be performed:

1) Normal Operation;

2) Communication Operation;

3) Electrical Supervision.

d) The installation instructions shall specify supply line transient protection complying with the Standard for Surge Protective Devices, UL 1449, with a maximum marked rating of 330 V.

e) The installation instructions shall specify signal line transient protection complying with the Standard for Protectors for Data Communications and Fire Alarm Circuits, UL 497B, with a maximum marked rating of 50 V.

f) The installation instructions shall specify that communication circuits and network components connected to the telecommunications network shall be protected by secondary protectors for communication circuits. These protectors shall comply with the Standard for Secondary Protectors for Communications Circuits, UL 497A, with a maximum marked rating of 150 V. These protectors shall be used only in the protected side of the telecommunications network.

g) The installation instructions shall indicate that receiving equipment be installed in a temperature controlled environment. A temperature controlled environment is defined as one that can be maintained between 13 – 35 °C (55 – 95 °F) by the HVAC system. Twenty-four hours of standby power shall be provided for the HVAC system. The standby power system for the HVAC system may be supplied by an engine driven generator alone. A standby battery is not required to be used.

h) All receiving equipment shall be completely duplicated with provision for switchover to the backup system within 30 seconds. The backup system shall be fully operational within 6 minutes of the loss of the primary system. This allows 30 seconds for the backup system to be fully energized and connected to necessary communication lines and other devices, followed by 5-1/2 minutes for the system to boot up, conduct memory tests, file system check, security verifications and prepare for full system operation. The backup computer shall have equivalent or greater capabilities of the primary, such as memory, speed and the like.

i) Failure of the main computer system, hard disk, and alarm monitor shall result in switchover to the backup system and shall be indicated by an audible or obvious visual indication.

j) The installation instructions shall specify that a fault tolerant system may be used in lieu of complete duplication of the system if every component in the fault tolerant system, including the software and the power supply, is duplicated.

k) The installation instructions shall specify that in addition to the main power supply and secondary power supply that are required to be provided at the central supervisory station, the equipment shall be provided with an uninterruptable power supply (UPS) with sufficient capacity to operate the computer equipment for a minimum of 15 minutes. If more than 15 minutes is required for the secondary power supply to supply the UPS input power, the UPS shall be capable of providing input power for at least that amount of time.

l) The installation instructions shall specify that the UPS shall comply with the Standard for Uninterruptible Power Systems, UL 1778, or the Standard for Power Supplies for Fire Protective Signaling Systems, UL 1481.

m) The installation instructions shall specify that in order to perform maintenance and repair service, a means for disconnecting the input to the UPS while maintaining continuity of power to the receiving equipment shall be provided.

n) A power conditioner used with the receiving equipment shall comply with the applicable requirements in the Standard for Power Units Other Than Class 2, UL 1012.

o) The installation instructions shall specify that no software other than the operating system software, monitoring software, and anti-virus/security protection software shall be installed on the primary and backup computers/servers.

p) The installation of all equipment used at the central/proprietary (monitoring) station shall be in compliance with the Standard for Central-Station Alarm Services, UL 827.

38 Remote Access

38.1 General

38.1.1 A remotely accessible system is a system that is able to be accessed with a device other than that located at the protected premises. The device can take the form of a smart phone/tablet, an internet-connected device, or any other means of accessing a burglar alarm system that is not using the control unit's human interface, albeit a wired and/or wireless keypad (arming station).

38.1.2 When equipment complies with the requirements in Section 38, the system shall be identified for Remote Access. Also see 38.1.14. These requirements apply to Central Station, Local, Police Station Connected and Proprietary, Burglar Alarm Systems. As indicated in the product installation instructions, Remote remote operation is prohibited from use in Holdup Alarm applications, or panic/emergency functions, where system commands should only be performed locally.

38.1.3 The burglar alarm system components and the software used in network connected and/or smart environments are within the scope of this standard[a]. The requirements for remote communication, remote operation, and software downloading and installation are given in 38.1 – 38.10 (inclusive). These requirements specifically address the operation of remote controlled control units that are intended to operate security control equipment located within the protected premises that may be physically unattended by the user.

[a] Also referred to as "control unit". Generally these include the protected premises control unit, accessories, and/or it's supporting system platform such as a monitoring station.

38.1.4 Validation of the user, performed through the remote device/connection, shall comply with the minimum security measures as detailed in 38.2.

38.1.5 The system, when being accessed remotely, shall operate as it would if it were being accessed from a control unit's human interface (keypad) located within the protected premises. As such, all other applicable operational requirements of this Standard shall also be applied to any remotely accessible functions.

Exception: Any action initiated by the control unit via a direct (trusted physical) path shall always take precedence over a remote action. See 38.1.9.

38.1.6 The use of remote access shall not compromise the integrity, change the intended use, or impair the operation of the burglar alarm system.

38.1.7 The manufacturer's intended remote access operation shall be defined in the product's installation and operating instructions.

38.1.8 A control unit shall be locally programmed or remotely programmed and securely configured per 38.1 – 38.3 for remote operation before remote access is to be permitted.

38.1.9 Any actions or control activity initiated by the control unit via a direct (trusted physical) path takes precedence and priority over a remotely actuated action.

38.1.10 When remote access features are employed, the manufacturer shall specify the minimum configuration consisting of the following:

a) Transmission technology employed (e.g. GSM, CDMA, HSPA, LTE), along with protocol name and version number if applicable;

b) Remote device operating system(s) and revision level, along with kernel version (if applicable);

c) Remote device application software and build revision levels. The application software shall be specifically developed by the manufacturer or its subsidiary and be proven compatible with specific control units/equipment; and

d) The burglar alarm system shall have the means to distinguish between the type of command/control information received from the local alarm system keypad versus that received from a remote device, via code or description. This user information, along with date/time stamp, shall be transmitted to the monitoring station (as applicable) so it is known which user (local vs. remote) has performed a specific system command.

e) All items above shall be documented in the product installation instructions.

38.1.11 The burglar alarm system shall allow the connection of a user under the following conditions:

a) As defined in the product installation instructions, a timeout feature, after a period specified by the manufacturer of no communication activity and/or no user connection, shall be implemented if the remote connection is lost, broken, or ended. The communication session shall be automatically terminated if it is idle for a maximum of 15 minutes;

b) There can be multiple remote connections per system at a time for monitoring/communication purposes only. Remote operation, remote service/maintenance, and/or software/firmware deployment must be performed first-in, first-out (FIFO); and

c) Access levels that are configured to provide specific functionality on the burglar alarm system shall then provide that functionality on the systems that the user is permissioned to execute.

d) Means shall be provided to detect repeated attempts to gain access not recognized as valid by the control unit. There shall be a mechanism to lockout the system or an individual user from future validation after a maximum of 5 unsuccessful attempts within a 10-minute period, as specified by the manufacturer in the product installation instructions. Further attempts during this time period shall be automatically disabled.

38.1.12 If closing (arming) the burglar alarm system remotely, an acknowledgment signal consisting of an audible and/or visual notification shall be provided to the remote device by the monitoring station to indicate that the closing signal has been properly received. See also 40.13.

38.1.13 When closing (arming) the burglar alarm system remotely, the control unit shall be programmed to arm the system without an exit delay. See also 6.44. This requirement must be noted in the product installation instructions.

38.1.14 When remote access features have been evaluated, the term “remote access” or the equivalent shall be provided as part of the product use marking shown in 89.2(c).

38.2 Validation of remote access credential

38.2.1 User validation – All remote access communications for the purpose of remote operation to the control unit shall comply with the authentication requirements detailed in this section.

a) There shall be an assigned “administrator” that has the rights to perform a software/firmware upgrade if this is allowable on the control unit. The administrator shall have priority over commands accessed by remote users.

b) All remote connections shall require defined users. The manufacturer of the control unit shall document any default users (such as factory authorized installers) in the product's installation

instructions or manuals. Any special "Undocumented users" (such as system administrators) defined for debugging or test purposes shall follow the rules of this entire section and shall ensure there is no security risk or unintended use of the control unit with an "Undocumented user".

38.2.2 There shall be a means to validate the identity of the user. This means shall be a user-name and credential that authenticates the validity of the identity of the user. A credential can be a password, PIN, biometrics, token, cryptographic mechanism, or key.

38.2.3 The validation means shall have a factory default or installation default that comes with the control unit at installation, for example a default PIN or password, with no biometrics or keys as a default.

38.2.4 The validation means shall have a way to reset or return to the factory or installation default.

38.2.5 The user validation means may be a combination of numbers, letters, and symbols. It shall be no less than 6 characters.

38.2.6 The user validation means shall have a way to modify or change the factory default credential during installation and setup.

38.2.7 A user validation mechanism as described in this section shall be used to modify or change any existing or new user validation data and shall be considered a remote operation if performed via a remote connection.

38.2.8 The transmission of the user validation mechanism or credential from a remote device via a remote connection to a control unit covered in this section shall be encrypted. (See Communication Data Integrity Standards, 38.4.)

38.2.9 When provided on the control unit, the storage of the validation mechanism or credential shall not be in plain text and shall be protected from unauthorized disclosure or modification.

38.3 Communication

38.3.1 All remote access connections shall be required to be authenticated and meet the requirements of 38.2.

38.3.2 Any remotely accessible features for maintenance and diagnostic testing shall either be disabled by default or when enabled, shall meet the requirements of this section, as well as 38.9 and 38.10.

38.3.3 Remote connection(s) from different sources shall not degrade the intended operation of the system at the protected premises and shall not cause any security compromise. A minimum of three different sources shall be used (e.g. Web server, smart phone, tablet, etc.).

38.3.4 The remote connection to a control unit shall be capable of withstanding a compromise attempt by the way of corruption of data, message alteration, spoofing, or replay between the sender and the receiver.

38.3.5 Invalid or incorrect data received by the control unit shall not impair the operation of the burglar alarm system or cause a security compromise.

38.3.6 Session termination (either intended or unintended) shall not impair the operation of the burglar alarm system or create a security compromise.

38.3.7 Evidence of compliance for the validation of approved communication security functions shall be provided. Compliance shall be from the National Institute of Standards and Technologies (NIST)

cryptographic algorithm validation program (CAVP) and shall be a current valid certificate for the security function used by the system and security function. (See Communication Data Integrity Standards, 38.4.)

38.4 Communication data integrity standards

38.4.1 Examples of standardized communication data integrity protection mechanisms are defined in the following:

a) Symmetric Algorithms and techniques:

1) NIST SP 800-67, Recommendation for the Triple Data Encryption Algorithm (TDEA) Block Cipher;

2) FIPS PUB 197, Advanced Encryption Standard.

b) Asymmetric algorithms and techniques:

1) FIPS PUB 186-4, Digital Signature Standard (DSS).

c) Message authentication codes and techniques:

1) FIPS PUB 198-1, The Keyed-Hash Message Authentication Code (HMAC).

d) Hash functions:

1) FIPS 180-4, Secure Hash Standard (SHS);

2) FIPS 198-1, The Keyed-Hash Message Authentication Code (HMAC).

e) Authentication Encryption:

1) NIST SP 800-38B, Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication;

2) NIST SP 800-38C, Recommendation for Block Cipher Modes of Operation: The CCM Mode for Authentication and Confidentiality;

3) NIST SP 800-38D, Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC.

38.5 Software/firmware upgrade

38.5.1 If the product covered in this standard allows for software or firmware to be modified outside of the manufacturer's facilities, then the product shall comply with this section. These requirements describe the testable criteria for established software/firmware deliverables onto the control unit and its evaluated/compatible system devices.

38.5.2 The software and firmware components described in this section shall include the following:

a) The software or firmware operating system of the product;

b) The application components of the product;

c) Any apps, applications or binary deliverables required to operate the product for its intended use of this standard; and

d) Any apps, applications or binary deliverables required to add non-safety features and functionalities to the product that are separate from the safety or performance features of the equipment.

38.5.3 The software and firmware components of this product shall use a mechanism of configuration management that is defined by the manufacturer. The configuration management mechanism shall maintain a version control and labelling policy to track and record different versions of software/firmware components.

38.5.4 The software and firmware components of this product shall be clearly documented in the product installation instructions and traceable by versions.

38.5.5 The product shall be able to easily display or demonstrate the version of the currently installed software and firmware components. Also see Version Number, Section 8.

38.5.6 The software and firmware components of the product shall be created and delivered such that it protects the previous operable code and all executable code from modification and disclosure from an unauthorized source.

38.5.7 Remote panel programming or configuration access shall require the use of a valid password, the panel's account or network address, and a unique credential or hardware key device to enable a remote programming mode. If an internet connection is used, the data shall be encrypted (see 38.5.9) and an audit trail shall be created in the subscriber control unit and/or the central (monitoring) station.

38.5.8 There shall be an acceptable integrity mechanism, to ensure that software and firmware installed remotely is not corrupted.

38.5.9 Evidence of compliance for the validation of approved communication security functions shall be provided. Compliance shall be from the National Institute of Standards and Technologies (NIST) cryptographic algorithm validation program (CAVP) and shall be a current valid certificate for the security function used by the system and security function. (See Data Integrity Standards, 38.6.)

38.6 Data integrity standards

38.6.1 Examples of standardized data integrity protection mechanisms are defined in the following:

a) Asymmetric algorithms and techniques:

1) FIPS 186-4, Digital Signature Standard.

b) Message authentication codes:

1) FIPS 140-2, Security Requirements for Cryptographic Modules;

2) FIPS 185, Escrowed Encryption Standard.

c) Hash functions:

1) FIPS 180-4, Secure Hash Standard (SHS);

2) FIPS 198-1, The Keyed-Hash Message Authentication Code (HMAC).

38.7 Software/firmware deployment process

38.7.1 The new software and firmware components shall be created with an approved software integrity mechanism to generate a factory code or signature for the binary. (See Data Integrity Standards, 38.6.)

38.7.2 Deployment of the software/firmware components to the control unit/system shall begin with the download of the software/firmware components which can be via a remote connection or direct physical connection.

38.7.3 If upgrade of the software/firmware components to the control unit/system interrupts the continued operation of the system, it shall be annunciated at the protected premises and the monitoring station.

38.7.4 After upgrade of the software component, a system integrity confirmation shall be performed, and meet the following conditions:

a) Upon successful completion of the re-programming, the integrity confirmation requires the control unit/system to generate a new integrity value in accordance with the standards noted in 38.6;

b) The integrity confirmation performs a comparison of the factory generated code or signature validated against the integrity value in (a) If the comparison fails, the integrity confirmation fails;

c) If the integrity confirmation fails and the burglar alarm system becomes inoperable, a trouble signal shall be annunciated locally and at the monitoring station;

d) If the integrity confirmation fails and the control unit/system can fully recover, it shall revert back to a previous known and functional state;

e) The comparison of the integrity mechanism shall only occur when the control unit/system has the complete software binary. It shall not be done prior to upgrade; and

f) The factory code or signature shall be included in the software binary and shall not be downloaded separately.

38.8 Event log

38.8.1 If a manufacturer incorporates an event-log, within their control unit, it shall be configured as follows:

a) Loss of power shall have no effect upon the event log;

b) The log shall be remotely accessible;

c) If a remote session is terminated unexpectedly and without proper sign-off, it shall be recorded; and

d) The manufacturer shall specify the period of time in which the log shall be preserved.

38.8.2 Each event logged shall, at a minimum contain:

a) Date of the event, or equivalent means to determine date;

b) The time of the event, or equivalent means to determine date;

c) An event identifier; and

d) The identification of the user who initiated the event.

38.9 Remote diagnostics connection

38.9.1 If a manufacturer allows access for the purpose of remote diagnostics, the requirements in 38.3 and 38.5 shall apply.

38.9.2 Multiple remote access connections to the burglar alarm system for the purpose of diagnostics shall be allowed.

38.9.3 A burglar alarm system providing the option to acquire information by a remote device shall implement machine to machine authentication using signed SSL Certificates.

38.9.4 Remote diagnostics shall not impair or interrupt the normal operation of the burglar alarm system.

38.10 Remote service and maintenance

38.10.1 If a manufacturer allows access for the purpose of remotely updating system software, configurations, and/or servicing of the burglar alarm system, the requirements in 38.3, 38.5 and 38.7 shall apply.

38.10.2 Remote access to the burglar alarm system shall be restricted to a single user per system at a time during remote service/maintenance.

38.10.3 Remote control is permitted during remote servicing/maintenance where a maximum time out of 4 hrs is provided.

39 Normal Operation Tests

39.1 General

39.1.1 A unit shall perform its intended function when installed in accordance with the requirements of this section and 39.2 – 39.6 as applicable.

39.1.2 As applicable, the requirements noted in this section and 39.2 – 39.6 shall be present in the product installation instructions, and the functions specified in 91.5(f) shall be verified as applicable.

39.1.3 The subscriber's control unit shall provide for the connection of protective wiring, conductors, and attachments in accordance with the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681, and as applicable, shall provide for the transmission of status change signals to a monitoring station in accordance with the Standard for Central-Station Alarm Services, UL 827.

39.1.4 A unit shall operate for all conditions of its intended performance when employed in conjunction with initiating devices and indicating devices to form a system combination of the type indicated by the installation wiring diagram and any supplementary information provided.

39.1.5 The unit is to be mounted in the intended manner and its terminals connected to initiating and indicating devices as specified by the installation wiring diagram to form a typical system combination. The product is then to be operated for each condition of its intended performance and shall not cause false operation.

39.1.6 Where extra terminals are provided to which field connections are not intended, the installation wiring diagram/instructions shall indicate the notation “No Connection”, “Do Not Connect”, or the equivalent.

39.1.7 The initiating devices, door contacts, floor mats, intrusion detection units, and the like, employed for testing are to be those specified by the installation wiring diagram. However, substitute devices may be used if they produce equivalent signal indication and circuit loading. Substitute load devices are considered to be those that have been found by investigation to provide the same load conditions as those obtained with the devices intended to be used with the product in service.

39.1.8 If equipment must be mounted in a definite position in order to function as intended, it shall be tested in that position.

39.1.9 Power-input supply terminals are to be connected to supply circuits of rated voltage and frequency. A product under test shall be in the normal supervisory condition ready for intended signaling operation when it is connected to related devices and circuits as specified in this section.

39.1.10 The protection circuit may be either an open circuit or closed circuit or a combination of the two. The circuits shall be fully supervised and an open in the circuit (or a closure) shall result in either an alarm or trouble signal. The operation of a detection device, such as a switch or motion detector, shall result in an alarm when the system is armed, and a trouble condition when the system is disarmed (unless the device is connected to a 24-hr alarm zone or other scheduling).

39.1.11 The system shall be arranged so that an alarm initiated from protective circuits cannot be stopped by removing the cause thereof.

39.1.12 Provision shall be made for the user to conveniently test the operability of the product each time it is placed on duty for the closed period.

39.1.13 An alarm silencing switch, if provided separately from an on-off switch, shall provide a visual signal indicating that the system is silenced.

39.1.14 A reset switch, if provided separately from an on-off switch, shall be of the momentary action self-restoring type.

39.1.15 The system shall not reset if the cause of the alarm has not been cleared.

39.1.16 A user must manually bypass each faulted zone to bring awareness of the potential lapse in coverage for a particular area/zone. A force arming feature (aka auto-arm, auto-bypass) is not permissible, and must be described as such in the product installation instructions.

39.1.17 As indicated in the product installation instructions, a time delay used to prevent an alarm during egress shall not exceed 60 seconds.

39.1.18 As indicated in the product installation instructions , a time delay used to prevent an alarm during entry shall not exceed the time established in 67.2.1.3 or 67.2.2.3 as applicable, and shall not in any case exceed 60 seconds.

39.1.19 If a system requires a key code to turn it off, the number of codes available shall not be less than 1000.

39.1.20 A system of the type described in 39.1.19 shall be provided with a tamper contact or the equivalent that will cause an immediate alarm or trouble signal at the monitoring station if the key code control (keypad) is opened in an attempt to defeat the system. See also 39.1.21.

Exception: For Local Burglar Alarm applications, annunciation of the tamper condition shall occur locally at the protected premises.

39.1.21 Tampering with, or removal of, a remote key code control (keypad) located outside the protected area shall cause an alarm or trouble signal at the monitoring station.

Exception: For Local Burglar Alarm applications, annunciation of the tamper condition shall occur locally at the protected premises.

39.1.22 Manually-operated switches used to initiate the system shall be guarded to prevent unintentional operation.

39.1.23 A burglar alarm unit and/or power supply operated from commercial power shall be provided with standby power sufficient to operate the product for the period specified in Power Failure, Section 57, in the event of loss of the primary source of power. Immediately following the standby period, the secondary power source shall have the capability to power an alarm sounding device for the time period specified in 39.1.25. The minimum and maximum capacity battery(ies) to be employed to meet this requirement shall be specified in the product installation instructions.

39.1.24 An alarm sounding device is required for local burglar alarm applications but considered optional for central station, proprietary, or police station connected applications. When one is used, it shall comply with the Standard for Audible Signal Appliances for General Signaling Use, UL 464, and with the audibility requirements given in 39.1.25, and 39.3.1 and 39.3.3 as applicable.

39.1.25 Upon the occurrence of an alarm condition, the alarm sounding device shall operate continuously for at least 15 minutes. The audible signal may have an automatic cutoff feature but it shall not operate in less than 15 minutes. This feature must be described in the product installation instructions.

39.1.26 In a system used in conjunction with a fire-alarm system, the audible alarm for burglary shall be distinct from the audible alarm for fire. The fire alarm audible signal shall be in accordance with the Standard for Household Fire Warning System Units, UL 985, or the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864, as applicable.

39.1.27 If a trouble signal is used, it shall be distinctive from an alarm signal, but in a combination system the same trouble signal may be employed for both burglar alarm and non-burglar alarm circuits.

39.1.28 Any supplementary types of signals shall be distinctive from burglary and fire, but may use the trouble signals.

39.2 Burglar alarm – central station; proprietary

39.2.1 Central Station and Proprietary burglar alarm units shall comply with the applicable requirements for construction and performance in this standard, as used in the applications specified in 6.28(a) and 6.28(e), respectively. In addition, these units shall comply with 39.1 and 39.3 as applicable, as well as the applicable requirements noted in Communication Operation, Section 40.

39.3 Burglar alarm – police station connected; local

39.3.1 Mercantile premises alarm systems

39.3.1.1 Police Station Connected and Local burglar alarm units shall comply with the applicable requirements for construction and performance in this standard, as used in the applications specified in 6.28 (d) and 6.28 (c), respectively. In addition, these units shall comply with 39.1 as well as with the requirements noted in this section.

39.3.1.2 Police Station Connected units shall also comply with the applicable requirements noted in Communication Operation, Section 40.

39.3.1.3 The protective circuits shall be of the electrically-supervised type, arranged to produce an alarm if the protective circuit is opened, if circuits of opposite polarity are crossed, or if an initiating device in the circuit transfers to the alarm condition.

39.3.1.4 A time delay of up to 1 second to prevent accidental alarms resulting from momentary breaks, crosses, leakage to ground, or the like, is acceptable in circuits where quick reaction to such alarm conditions is not required.

39.3.1.5 For local burglar alarm applications, a control unit that has a field programmable alarm sounding circuit shall be programmed to conduct a test of the alarm sounding device when the system is armed.

39.3.1.6 The alarm sounding device shall comply with the requirements of UL 464, Standard for Audible Signal Appliances for General Signaling Use, and shall, in addition, comply with the requirements of this section.

39.3.1.7 The alarm sounding device, mounted within its intended housing and in its intended mounted position, shall provide a sound output equivalent to that of an omnidirectional source with an A-weighted sound pressure level of at least 85 decibels at 10 feet (3.05 m) while connected to a source of rated voltage. See 35.4.1.

39.3.1.8 The output specified in 39.3.1.5 shall not be less than 82 decibels when the voltage is reduced to the minimum value specified in the Undervoltage Operation Test, Section 46.

39.3.1.9 The alarm sounding device, with its power supply, shall produce sound at the level specified in 39.3.1.5 for not less than 15 minutes.

39.3.1.10 As indicated in the product installation instructions, an alarm cutoff feature shall not operate in less than 15 minutes.

39.3.1.11 For police station connected applications, the sounding of the protected premises audible alarm may be delayed by not more than 5 minutes, but the transmission of an alarm to the police station shall be delayed not more than 60 seconds after the alarm has been initiated. See 39.1.17, 39.1.18.

39.3.1.12 There shall be an indication, at the time of setting the system, that all protection up to the egress door is set for duty.

39.3.1.13 The system shall be such that the setting of closed-circuit wiring, detection devices, or alarm sounding device circuits is not dependent upon the operation of an egress-door-actuated switch or transfer mechanism on the door unless failure of these switches to operate as intended at closing time gives position indication to the user.

39.3.1.14 Key-operated controls located outside of the protected area shall employ high-security locking cylinders complying with the Standard for Key Locks, UL 437.

39.3.1.15 Switches other than the entrance door shunt, that permit convenient shunting of portions of the protection by the user, shall not be used unless audible or visual indicators, or both, are provided to remind the user to remove the shunt.

39.3.1.16 There shall be constant indication to the user, of the condition of the protection circuit power supply.

39.3.1.17 Either a graduated milliammeter in the protection circuit or an under load device adjusted to operate a trouble signal when the current in the protection circuit drops to a certain value are acceptable methods of supervising the condition of the protection-circuit power supply.

39.3.1.18 The system shall be arranged to provide at least one daily automatic test of the sounding device and its source of energy. This feature shall be described in the product installation instructions.

39.3.2 Mercantile safe and vault alarm systems

39.3.2.1 Systems for mercantile safes and vaults shall comply with the requirements for mercantile premises, or shall provide equivalent protection, and shall comply with the requirements of this section. See also 41.12. In addition, police station connected line security equipment must also comply with the requirements in Standard Line Security Equipment, 40.14, and/or Encrypted Line Security Equipment, 40.15, as applicable.

39.3.2.2 The leads providing operating power to the alarm sounding device shall be electrically and mechanically protected as required in the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681, or the circuit shall be constructed so that the system is not defeated by cutting or short-circuiting connections between the control unit and the alarm housing.

39.3.2.3 If the system makes provision for connection of vault or safe wiring to the same circuit and to the same alarm housing used with premises wiring on the surrounding premises, tampering with the premises wiring shall not defeat the safe or vault wiring.

39.3.3 Bank safe and vault alarm systems

39.3.3.1 Systems for bank safe and vault burglar alarm units shall comply with the requirements specified for mercantile safe and vault alarm systems, and with the requirements in this section.

39.3.3.2 All systems shall employ a closed-circuit cable for connecting the safe or vault to the alarm housing so that an alarm is produced if the cable is severed or disconnected.

39.3.3.3 When the system is placed on duty, a timer in the system shall prevent the turning off, prior to a time set by the user, of the door protection and of other circuits that are inoperative during the open period. The timer shall be capable of covering a closed period of at least 96 hours (4 days). This feature shall be described in the product installation instructions.

39.3.3.4 The door protection and other circuits that are inoperative during the open period shall be arranged so that they are placed on duty manually at the time of closing or automatically by the timer within 30 minutes after closing of the door and setting of the system for the closed period. This feature shall be described in the product installation instructions.

39.3.3.5 The requirements of 39.3.3.3 and 39.3.3.4 may be provided by a 7 day (1 week) timer that will automatically place the protection on duty not later than 10 p.m. and remove it not sooner than 6 a.m. the next business day. These times may be revised if they conflict with normal business hours of the protected vault or safe. The timer shall automatically maintain the protection on duty on Sundays and holidays. An electrically protected key or combination control shall be provided for the user to change the ON and OFF times and to adjust the holiday carry-over as required. If employed, this feature shall be described in the product installation instructions.

39.3.3.6 An audible or prominent visual signal (or absence thereof) shall indicate automatically to the user if winding of any time-control mechanism is neglected.

39.3.3.7 The main protective circuits, linings, and attachments on the safe or vault, control units, and alarm housing shall be of the normally closed circuit fully supervised type.

39.3.3.8 Auxiliary protection circuits used to supplement or reinforce the main protective devices on these units may be of the non-supervised type.

39.3.3.9 Systems employing sound-, vibration-, or proximity-detector systems shall include provision for testing the operation of detectors and all associated relays and circuits without sounding the alarm. See Intrusion and Perimeter Detection Devices, 39.5.

39.3.3.10 Provision shall be made for a separate test of detectors in each safe or vault connected to a single control unit.

39.3.3.11 The alarm sounding device shall comply with the requirements of UL 464, Standard for Audible Signal Appliances for General Signaling Use, and shall, in addition, comply with the requirements of this section.

39.3.3.12 The alarm sounding device mounting within its intended housing and in its intended mounting position, shall provide a sound output equivalent to that of an omnidirectional source with an A-weighted sound pressure level of at least 87 decibels at 10 feet (3.05 m) while connected to a source of rated voltage. See 35.4.1.

39.3.3.13 The output specified in 39.3.3.12 shall not be less than 84 decibels when the voltage is reduced to the minimum value specified in the Undervoltage Operation Test, Section 46.

39.3.3.14 As indicated in the product installation instructions, the alarm sounding device, with its power supply, shall be capable of sounding at the level specified in 39.3.3.12 for:

a) Not less than 15 minutes nor more than 30 minutes if the alarm condition has not cleared; or

b) Not less than 5 minutes if an automatic feature is provided to silence the alarm and reset the system if the alarm system has cleared.

39.3.3.15 A mechanical ringer shall give an indication automatically to the user when only 5 minutes operating power remains in the sounding device.

39.3.3.16 For police station connected applications, the sounding of the local alarm may be delayed by not more than 5 minutes, but the transmission of an alarm to the police station or central station shall be delayed not more than 60 seconds after the alarm has been initiated. See 39.1.17 and 39.1.18.

39.3.3.17 If the system design provides for two electrically powered alarm sounding devices, and one is to be mounted inside and one outside the building, the inside alarm shall have resistance to tampering and an audibility equal to that specified for a single outside alarm.

39.3.3.18 There shall be provision for testing of automatic meter supervision over all sources of electrical energy. If testing is used, it is to be made under load with the sounding device operating.

39.3.3.19 Switches provided on the control unit by use of which the user can turn off portions of the protection or turn off the alarm, shall give an audible or prominent visual indication to the user as long as the switches remain in the inoperative position.

39.4 Holdup alarm

39.4.1 Holdup alarm units shall comply with the applicable requirements for construction and performance in this standard, as used in the application specified in 6.28(b). In addition, these units shall comply with 39.1, as well as the applicable requirements noted in Communication Operation, Section 40, as necessary.

39.4.2 A holdup alarm signal shall be transmitted directly to a constantly staffed police station equipped for broadcasting radio calls to cruising squad cars, or to a central station with facilities for relaying calls to a law enforcement agency with such broadcasting facilities. The central station shall comply with the Standard for Central-Station Alarm Services, UL 827.

39.4.3 Holdup alarm initiating devices as specified in this standard shall be of the fully supervised type.

39.4.4 A holdup alarm initiating device shall lock into the alarm position when it is operated and shall require being manually reset or it shall display a visual indication of having been operated at the device, at the control unit, or at the location where the holdup alarm signal is received. The visual indication shall require manual reset.

39.4.5 Each holdup alarm initiating device shall require positive, intentional action to initiate a holdup alarm signal.

39.4.6 As indicated in the product installation instructions, each manually operated holdup alarm initiating device shall be installed so that it cannot be observed by the public and so that it can be operated in a manner that will not be obvious to an attacking party. Each semiautomatic holdup alarm initiating device shall be installed so that it is not noticeable to an attacking party during a holdup attempt and is not noticeable to the public or an attacking party prior to a holdup attempt.

39.4.7 An "open" in the off-premises communication circuit shall produce a trouble signal either at the premises or guard station, and shall produce an alarm signal at the central monitoring station or police station.

39.4.8 A short-circuit in the off-premises communication circuit, if sufficient to prevent transmission of an alarm, shall produce a trouble signal either at the premises or a guard station, and shall transmit an alarm signal to the central monitoring station or police station.

39.4.9 The trouble signal at the premises may be omitted on systems supervised continuously by a central monitoring station or police station.

39.4.10 The systems shall be arranged so that when an alarm is initiated and transmitted it will continue to register until manually reset by controls intended for the purpose in the protected premises.

39.4.11 If an alarm signal is annunciated at a guard station, it shall be of a type which is distinctly audible anywhere within the guard station. The audibility shall be determined at the minimum voltage specified in the Undervoltage Operation Test, Section 46.

39.4.12 A test switch that permits shunting of portions of the protection shall restore to the non-shunting position automatically or shall give a visual indication, audible indication, or both, when in the non-operative position.

39.4.13 The operation of an initiating device at the protected premises, and transmission of an alarm to a guard station, central station, and/or police station, shall not produce within the premises a signal which may be audible or visible to the attacking party.

39.4.14 Systems operated in conjunction with other types of alarm systems shall produce a signal at the guard station, central station, and/or police station intended to identify it as a holdup alarm.

39.4.15 Installation of holdup alarm units and systems shall be governed by the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681.

39.5 Burglar alarm power supplies

39.5.1 Burglar alarm power supplies shall comply with the applicable requirements for construction and performance in this standard, and shall operate as intended in accordance with the applicable requirements noted in 41 – 82.

39.6 Outside alarm devices

39.6.1 Outside sounding devices shall be of the enclosed type and shall comply with the Standard for Audible Signal Appliances for General Signaling Use, UL 464, for outdoor use and with the audibility requirements given in 39.3.1.7 – 39.3.1.10 and 39.3.3.11 – 39.3.3.14. Also see Outdoor Use Equipment, Sections 71 – 82.

39.6.2 The construction of the outside alarm housing shall be such that it will shed water when mounted as intended. Sufficient drain openings shall be provided in the lowest part of the housing to prevent accumulation of water. See the Rain Test, Section 76.

39.6.3 Protective linings employed in housings shall be sealed in a moisture-tight envelope unless of rust resisting material or treated to resist corrosion. If air is depended upon for insulation, "live" linings shall be spaced not less than 1/4 inch (6.4 mm) nor more than 1 inch (25.4 mm) from the housing or other parts that would result in an alarm if they contact the protective lining.

39.6.4 Instruments and connecting wire shall be located at a sufficient height above the bottom of the housing to avoid saturation with water, snow, and the like.

39.6.5 Ringing mechanisms and other apparatus in housings subject to vibration shall be mounted with lock washers or the equivalent to prevent loosening.

39.6.6 Installation of an outside alarm device shall be governed by the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681.

39.7 Intrusion and perimeter detection devices

39.7.1 Intrusion detection components of a burglar alarm unit/system, such as a motion detector, proximity detector, sound detector, vibration detector, or the like, shall comply with the Standard for Intrusion-Detection Units, UL 639. In addition, the requirements of this standard shall apply as appropriate.

39.7.2 Perimeter detection components of a burglar alarm unit/system intended for use in protective circuits to supervise doors, windows, hatches, etc., such as magnetically-actuated switches, mercury

switches, floor mats, or the like, shall comply with the Standard for Connectors and Switches for Use with Burglar-Alarm Systems, UL 634. In addition, the requirements of this standard shall apply as appropriate.

40 Communication Operation Tests

40.1 General

40.1.1 This section describes the requirements for the transmission path(s) between the protected premises and the monitoring station, and/or the communication path (s) between remote satellite/ subsidiary station(s) and the monitoring station. Also see Table 40.1.

Table 40.1
Off-Premises Communication Equipment

Communication type	Communicator method	Communication check-in/Polling times			
		Single path	Dual path[a,b]	Alternate primary w/single path[c,e]	Alternate primary w/dual path[b,c,e]
Public Switched Telephone Network (PSTN)	DACT	24 hr	360 sec primary/ 24 hr secondary	N/A	360 sec primary/ alternate primary; 24 hr secondary
Cellular	Cellular DACT	24 hr	360 sec primary/ 24 hr secondary	N/A	360 sec primary/ alternate primary; 24 hr secondary
Managed Facilities-Based Voice Network (MFVN)[d]	DACT via IP	200 sec	360 sec primary/ 200 sec secondary	200 sec primary/ 200 sec alternate primary	360 sec primary/ alternate primary; 360 sec secondary
Code Transmitter	McCulloh	1 hr	360 sec primary/ 1 hr secondary	N/A	360 sec primary/ alternate primary; 1 hr secondary
One-Way RF	One-Way Radio	24 hr	360 sec primary/24 hr secondary	N/A	360 sec primary/ alternate primary; 24 hr secondary
Two-Way RF	Two-Way Radio	200 sec	360 sec primary/ 200 sec secondary	200 sec primary/ 200 sec alternate primary	360 sec primary/ alternate primary; 360 sec secondary
Multiplex	Multiplex	200 sec	360 sec primary/ 200 sec secondary	200 sec primary/ 200 sec alternate primary	360 sec primary/ alternate primary; 360 sec secondary
Packet Switched Data Networks (PSDN)	IP, GSM, GPRS, etc.	200 sec	360 sec primary/ 200 sec secondary	200 sec primary/ 200 sec alternate primary	360 sec primary/ alternate primary; 360 sec secondary

[a] Standard Line Security (or Encrypted Line Security) is required on one of the paths.

[b] Products must be in compliance with the applicable Exceptions per 40.8 to qualify for 360 sec check-in/polling.

[c] The same level of Line Security is required on both the primary and alternate primary paths. See 40.2.3 or 40.8.10.

[d] Managed Facilities-Based Voice Networks (MFVN) employ “Voice over IP (VoIP)” technology governed by the PSDN requirements in 40.7.

[e] The alternate primary path is only active when the primary path fails and is brought into service before the next check-in/polling time interval.

40.1.2 The transmission path from the protected property consists of the following four elements:

1) The means of transmission from the protected property;

2) The premises demarcation point, consisting of the connection point and intermediate Information Technology Equipment, provided at the protected premises that may or may not be supplied as part of the alarm system;

3) The communication cloud through which signals are transmitted to the monitoring station; and

4) The monitoring station such as central station, hosted central station, proprietary station, police station, or the equivalent.

40.1.3 Where utilized, dual path transmission systems shall provide for redundancy as indicated in Dual Path Transmission Methods, 40.8.

40.1.4 A single break (open), wire-to-wire short, or ground fault on any transmission or communication circuit shall not cause a local alarm signal, or affect the required operation of the burglar alarm system, other than the loss of the faulted communication circuit.

40.1.5 As indicated in the product installation instructions, loss of communication with the monitoring station shall be treated as an alarm condition by monitoring station personnel when the burglar alarm system is in the armed state, and as a trouble condition while the system is disarmed.

40.1.6 Loss of communication between the protected premises and the monitoring station shall be annunciated at both the monitoring station and the protected premises in accordance with the time parameters noted in Table 40.1.

Exception: The local annunciation requirement noted above is not applicable to proprietary burglar alarm systems that are constantly monitored by the central supervisory station.

40.1.7 The utilization of a double loop or redundant conductors or circuits to avoid electrical supervision does not meet the intent of the requirements in 40.1.4.

40.1.8 The protected premises alarm controls shall be such that the act of opening (disarming) and/or closing (arming) the protected premises in the prescribed manner does not transmit an alarm.

40.1.9 Signals shall be indicated both audibly and visually at the monitoring station receiving equipment.

40.1.10 As evaluated, the protected premises communicator(s)/equipment and the monitoring station receiver(s) proven to be compatible with the requirements of this standard must be specifically described in the product installation instructions.

40.1.11 As applicable, the off-premises communicator and/or its power supply may be subject to attack resistance requirements. See Attack Tests, Section 67.

40.2 Single path transmission methods

40.2.1 Signals shall be transmitted by one (or more) of the following methods:

a) Code Transmitter (McCulloh) (see 40.3.1);

b) DACT (see 40.3.2):

1) PSTN;

2) Cellular;

3) MFVN (see 6.69).

c) One-Way Radio (see 40.4);

d) Two-Way Radio (see 40.5);

e) Multiplex (see 40.6);

f) Packet Switched Data Networks (PSDN) (see 40.7).

40.2.2 The specific transmission function as indicated in 40.2.1 shall be provided as part of the product use marking shown in 89.2(c).

40.2.3 A system may also employ an alternate primary path for off-premises communication. A single path transmission system with an alternate primary path is one in which the alternate primary path provides the same level of integrity as the primary path and is brought into service before the next check-in/polling time interval should the primary path become inoperative. In addition, both the primary and the alternate primary paths shall be provided with the same level of Line Security (e.g. both have Standard Line Security, both have 128-bit Encrypted Line Security, both have 256-bit Encrypted Line Security).

40.2.4 The alternate primary path shall comply with all the applicable requirements in Section 40.

40.2.5 The time lapse between the occurrence of the faults described in 40.6.11 and the annunciation and recording of those conditions at the monitoring station shall not exceed 200 seconds, on both the primary and alternate primary paths.

40.3 Transmitter systems

40.3.1 Code transmitter (McCulloh)

40.3.1.1 As used in this standard, the term "code transmitter (McCulloh) system" refers to a system that provides for the connection of more than one protection system to a single alarm receiving unit.

40.3.1.2 Connection between the subscriber's protective wiring and the monitoring station shall be affected by means of a code transmitter connected to or integrated with the subscriber's control unit. Under this arrangement, placing the subscriber's control unit in the armed condition shall cause transmission of a closing signal. Any disturbance of the subscriber's protective system during this period when protection is set shall immediately operate the code transmitter, thereby signaling the monitoring station.

40.3.1.3 The monitoring station communication circuit shall be of the closed-circuit (supervised) type. Signals from the premises code transmitters shall normally be affected by opening this circuit.

40.3.1.4 Circuitry within the monitoring station and communication circuitry connecting code transmitters to the monitoring station shall be arranged so that neither a single break, wire-to-wire short, nor a single ground in the line can prevent the reception of signals from any code transmitter on that circuit.

40.3.1.5 The communication circuitry specified in 40.3.1.4 shall be arranged so that a break, short, or a ground in the line causes a signal at the monitoring station that calls the operator's attention to, and identifies, the nature of the trouble.

40.3.1.6 A visual indication to the operator shall be activated whenever the circuit is being operated with a break, short, ground, or other impairment.

40.3.1.7 To check that both lines connecting a code transmitter to the monitoring station have not been severed, shorted, or grounded, either an hourly automatic test signal shall be transmitted from each

subscriber's premises during the closed (armed) period, or the monitoring station operator shall, at will, be able to cause each code transmitter to send in a test signal.

Exception: Hourly test signals are not required if either:

a) Monitoring station lines enter the premises in underground cables; or

b) These lines enter and leave the premises at separate points at least 10 feet (3.1 m) apart and the subscriber's protective circuit is installed with the monitoring station line to the nearest junction.

The methods of installation above shall be included in the product installation instructions.

40.3.1.8 The test signals specified in 40.3.1.7 shall provide supervision of both the subscriber's protective circuit and the connecting line between the monitoring station and the code transmitter.

40.3.1.9 Code signals shall be received at the monitoring station on a tape register or other recording instrument. The recording instrument shall print records either in ink or another medium having equivalent permanence.

40.3.1.10 An audible supervisory signal shall sound while a code signal is being received. A common audible signal may be used.

40.3.1.11 Each communication circuit shall be provided with a visual supervisory signal which shall be visible during the time a signal is being received from any equipment on its circuit. The arrangement shall identify the circuit from which the signal is being transmitted.

40.3.1.12 If provision is made to prevent signal clash between code transmitters on the same signaling circuit, there shall not be loss of signals from any code transmitter on the communication circuit due to:

a) Two or more simultaneous transmissions; or

b) A second code transmitter operating before the first has completed its transmission.

40.3.1.13 If a subscriber's protective circuit is disturbed, the code transmitter shall transmit the code signal to the monitoring station and shall repeat this code not less than three times.

40.3.1.14 A subscriber control unit used in a code transmitter system shall transmit an alarm signal to the monitoring station if the protective circuit is opened, if its conductors of opposite polarity are crossed, or if an initiating device in the circuit transfers to an alarm condition.

40.3.1.15 The transmitting mechanism shall be enclosed in an electrically protected enclosure. Protection for the transmitting mechanism shall comply with the requirements in the Attack Tests, Section 67.

40.3.1.16 Electrically operated code transmitters shall be provided with supervision of both their source of energy and their driving mechanism.

40.3.1.17 Spring-wound or mechanically operated code transmitters shall be provided with supervision over the wound condition of the mechanism.

40.3.1.18 Winding keys projecting outside of the case shall not enable application of enough torque to stop the mechanism before one complete round of the code signal is transmitted.

40.3.1.19 Means shall be provided whereby the subscriber may test the protection at closing (arming). The results of a positive test shall be indicated by visual or audible means.

40.3.1.20 A normal closing (arming) signal shall not be transmitted if the protection is not set when the subscriber control unit is placed in the operating mode used for a closed period (protection on).

40.3.2 Digital alarm communicator transmitter (DACT)

40.3.2.1 These requirements cover digital alarm communicator system units for use in central-station burglar-alarm systems, proprietary burglar alarm systems, police station connected burglar alarm systems, and holdup alarm systems. The requirements in this section also apply to cellular communicator transmitters that convert DACT signaling into digital cellular technology. Managed Facilities-Based Voice Networks (MFVN) (or “Voice over IP” (VoIP) networks) are covered by the requirements in Packet Switched Data Networks (PSDN), 40.7.

40.3.2.2 The digital alarm communicator transmitter unit shall comply with the construction, safety, and/or installation instruction requirements for protection against overvoltage from power line crosses described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

40.3.2.3 A need for off-premises transmission will activate the digital alarm communicator transmitter (DACT) that contacts a digital alarm communicator receiver (DACR) located at a monitoring station through the telephone company's switched network (PSTN) and transmits a message identifying the change in condition at the protected premises.

40.3.2.4 All data exchanged between the transmitter at the protected premises and the receiver at the monitoring station shall be by digital code or equivalent. Signal repetition, digital parity check, or some equivalent means of signal verification shall be used.

Exception: A voice message may be used to provide supplementary data only.

40.3.2.5 If the digital alarm communicator transmitter is required to send a message to the monitoring station, it shall seize the telephone line at the protected premises, cut off any outgoing telephone call in progress, and prevent use of the line for future outgoing telephone calls until the signal transmission has been completed and the digital alarm communicator transmitter disconnects.

40.3.2.6 In addition to the requirement of 40.3.2.5, the digital alarm communicator transmitter shall also disconnect any incoming call to free the telephone line for a signal transmission. See 40.3.2.7. This requirement will preclude the use of a digital alarm communicator system in a telephone system where the disconnection of an incoming call cannot be obtained if the calling party does not go on-hook (hang up).

40.3.2.7 The digital alarm communicator transmitter shall obtain a dial tone by one of the methods specified in either (a) or (b):

a) After going off-hook, the transmitter shall wait for 3 to 7 seconds before beginning the dialing process. If additional attempts are needed to contact the central-station, the wait may be lengthened before beginning the dialing process.

b) After going off-hook, the transmitter shall wait until the dial tone frequency(s) has been detected and then begin the dialing process. The wait for the dial tone shall not exceed 7 seconds. If the dial tone has not been detected within 7 seconds, the transmitter shall go on-hook, wait for a predetermined period of time, go off-hook and start the sequence again. On the second and subsequent attempts to detect the dial tone, the wait may exceed 7 seconds.

The time spent on-hook between attempts for method (a) or (b) shall be sufficient to cause the telephone company's system to disconnect any incoming call that may have been present when the transmitter went off-hook. See 40.3.2.6.

Exception: The wait of 3 to 7 seconds specified in (a) may be shortened or lengthened if the telephone system in which the transmitter is being used permits or requires it.

40.3.2.8 After the digital alarm communicator transmitter has contacted the digital alarm communicator receiver:

a) It shall verify that contact has been made with the proper receiver and obtain verification that the receiver is ready to receive signals (handshake signal);

b) The transmitter shall send its message;

c) The receiver shall verify that the message is valid; and

d) The transmitter shall switch to on-hook (disconnect) as soon as the verification of its final message and action is received from the digital alarm communicator receiver (kiss-off signal).

The probability of verifying an invalid signal shall be a ratio of 1 to 1000 or less.

40.3.2.9 The digital alarm communicator transmitter and receiver units shall provide for the conditions specified in (a) and (b):

a) If the transmitter does not receive a signal verifying that contact had been made with the receiver, it shall go on-hook after waiting no more than 45 seconds and then attempt to make contact again.

b) If the transmitter does not receive a sign-off (kiss-off) signal indicating that a valid message has been received, verified and accepted, the transmitter shall go on-hook, and then attempt to make contact and deliver the message again. The transmitter may send the message a second time before going on-hook, but shall not wait more than 5 seconds for the sign-off (kiss-off) signal in any case.

40.3.2.10 The DACT shall make no less than five, nor more than ten, attempts to contact the monitoring station receiver, deliver an acceptable message, and receive a sign-off (kiss-off) signal. If the transmitter has made the maximum number of attempts to contact the receiver and has not received an acceptable sign-off (kiss-off) signal, an indication of this failure shall be presented to the alarm system user.

Exception No. 1: There may be an indication to the alarm system user that an attempt has been made to contact the monitoring station receiver during the armed mode whether contact was actually made or not, but a signoff (kissoff) signal as described in 40.3.2.11 is still required as confirmation that the transmission has been successful.

Exception No. 2: If the transmission line has been restored prior to completing the maximum number of contact attempts and all stored signals have been sent, or a communication failure message has been delivered to the monitoring station, the failure to communicate indicator at the protected premises does not need to latch in.

40.3.2.11 When the digital alarm communicator transmitter is placed into the armed mode, the receipt of the sign-off (kiss-off) signal indicating a successful transmission shall be indicated to the user by audible, visual, or both types of signals. If a backup line is used with the transmitter (see 40.3.2.12, the condition of that line, normal or abnormal, shall be indicated to the alarm user when the system is placed into the armed mode.

40.3.2.12 The telephone line connected to the digital alarm communicator transmitter shall be supervised as specified in either (a) or (b):

a) Two telephone lines shall be used and the transmitter shall be able to switch from one to the other. Both telephone lines shall be monitored so that if a fault develops on either one, the transmitter will contact the receiver through the remaining line to report the fault and identify it as a telephone line trouble. In systems having telephone instruments without bell-ringing capacitors, the fault shall be present at least 15 seconds but no more than 45 seconds before the trouble signal is transmitted. In systems having telephone instruments with bell-ringing capacitors, the time to detect a fault may be approximately 65 seconds for each telephone instrument on the line. Therefore, no more than two telephone instruments shall be on each of the two telephone lines. It is suggested that the telephone line used for primary reporting be connected to no more than one instrument.

b) The transmitter shall contact the receiver with an identifiable signal at least once every 24 hours. The normally scheduled opening signal, closing signal, or any other signal may be used for this purpose. If none of these signals are transmitted during a 24-hour period, an identifiable signal, used for this specific purpose, shall be transmitted.

40.3.2.13 If telephone line supervision is provided as described in 40.3.2.12(a) the transmitter shall switch to the secondary telephone line after one or two attempts to make contact with the receiver on the primary telephone line. After making one or two attempts on the secondary telephone line, the transmitter shall switch back to the primary line. This sequence shall be continued until the transmitter has made the number of attempts required in 40.3.2.10.

40.3.2.14 A digital alarm communicator receiver unit shall accommodate a minimum of two incoming telephone lines. Incoming transmissions shall go to the first available line.

40.3.2.15 A message shall be displayed:

a) On a visual display and a printer;

b) on a minimum of two printers; or

c) by any other equivalent dual means.

A permanent recording of each message shall be made.

40.3.2.16 Each message shall initiate an audible signal that shall continue to sound until manually reset. The audible signal may be silenced separately from the clearing of the visual display. See 40.3.2.17.

40.3.2.17 When a visual display and a printer are used, the printer shall automatically record each message as it is received. The message shall also be automatically shown on the visual display and shall remain visible, or be periodically repeated (scrolled), until manually cleared. The printer or visual display shall continue its operation when the other is out of service.

40.3.2.18 When two or more printers are used, they shall operate as specified in either (a) or (b):

a) A minimum of two printers shall automatically record each message received; or

b) One printer shall automatically record each message received and a standby printer shall be provided that can be put into service within 30 seconds. Failure of an operating printer shall result in audible and visual signals that identify the failed printer. The ratio of standby printers to operating printers shall not be less than 1 to 5.

40.3.2.19 Messages shall be displayed in an alphanumeric code, numeric code, written text, or equivalent code that will identify the transmitter and the nature of the condition that has caused the message to be transmitted.

40.3.2.20 An opening, closing, alternating current power failure, battery failure, or the like, shall be distinguished from alarm signals. An opening (disarming) and closing (arming) signal shall be identified as such.

40.3.2.21 If the digital alarm communicator receiver is automated or connected to a central station automation system, only those messages that require action by an operator need be displayed, for example an unauthorized entry, power failure, battery failure, and the like. Messages relating to opening (disarming) and closing (arming) within the established time intervals shall cause a response by the automated system and shall be recorded in a manner that will allow recall and display by an operator or other authorized monitoring station personnel. Automated systems shall comply with the requirements for automated central station systems in the Standard for Central-Station Automation Systems, UL 1981, and the applicable requirements in this standard.

40.3.2.22 If the digital alarm communicator transmitter determines that opening (disarming) and closing (arming) signals are acceptable or unacceptable, a transmission only once every 24 hours to the monitoring station is required if the method of supervision specified in 40.3.2.12(b) is used.

40.3.2.23 With reference to the requirements of 40.3.2.22, a digital alarm communicator transmitter may determine an acceptable or unacceptable opening (disarming) and closing (arming) as specified in either (a) or (b). The indication of a successful closing signal transmission required by 40.3.2.11 is not required under these conditions.

a) The day to day opening and closing schedule shall be established in the memory of the transmitter so that an opening (disarming) or closing (arming) taking place at an acceptable time will not cause a transmission to the monitoring station. An opening (disarming) or closing (arming) taking place at an unacceptable time will result in a transmission of this condition to the monitoring station. The opening and closing time parameters shall comply with the Standard for Central-Station Alarm Services, UL 827.

b) The alarm user shall be provided with a code that when entered in combination with the action of an opening or closing, shall prevent the DACT from sending a message to the monitoring station. Entry of an incorrect code shall result in a transmission to the DACR.

40.3.2.24 With reference to the requirements of 40.3.2.23(b), there shall not be less than 10,000 codes available for use in the system. A combination of codes may be used by each alarm user and each combination may have different levels of acceptance.

40.3.2.25 The scheduled openings and closings acceptable under the requirements of 40.3.2.23, shall be stored and transmitted to the central-station receiver for recording when the transmitter makes its check-in transmission once every 24 hours. Equivalent methods of storing and recording of the scheduled openings and closings may be used.

40.3.2.26 To prevent the transmission of an alarm signal before an acceptable opening has been initiated, an entry alarm caused by the alarm user entering the protected premises may be delayed up to 45 seconds. However, this delay time shall be added to the attack time specified in 67.2.1.2(b).

40.3.2.27 A digital alarm communicator transmitter shall either be an integral part of the subscriber's control unit or a separate unit that can interface with a subscriber's control unit. As applicable, a separate unit shall comply with the cover and/or rear tamper requirements in this standard.

40.3.2.28 A digital alarm communicator transmitter shall be connected into the telephone switched network (PSTN) and programmed to contact a digital alarm communicator receiver with which it is compatible. The compatible DACR shall be indicated in the product installation instructions.

40.4 One-way radio (RF) systems

40.4.1 Systems employing one-way radio for off-premises communication to the monitoring station shall comply with the applicable requirements in the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864, as well as any operational or attack test requirements of this Standard.

40.5 Two-way radio (RF) systems

40.5.1 Systems employing two-way radio for off-premises communication to the monitoring station shall comply with the multiplex requirements of this standard, 40.6, as well as with the applicable requirements in the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864, as well as any operational requirements of this Standard.

40.6 Multiplex systems

40.6.1 As used in this standard, the term "multiplex system" refers to a system using a method of signaling characterized by the simultaneous or sequential transmission and reception of multiple signals over a single communication channel and provision of means to positively identify each signal. The signaling may be accomplished over a wire path, telephone communication channel, radio carrier, packet switched data networks, or any combination of these. A two-way radio system shall be considered as a multiplex system.

40.6.2 The signal may be transmitted from the protected premises system directly to the monitoring station, or through either a satellite or subsidiary station.

40.6.3 Any change in the status of the protection circuit which is initiated at the protected premises shall be indicated at the monitoring station by audible and visible means. Opening (disarming), closing (arming), alarm, trouble, and their restoration to normal, are considered status change signals.

40.6.4 A change in status shall be automatically recorded. The record shall identify the system, indicate the new status, and include the time and date. A recording device shall consist of either a printer or magnetic medium or other nonvolatile electronic memory capable of being viewed or printed immediately upon request. The year may be manually recorded and need not be shown for each recording. Recorded signals shall be stored in accordance with the applicable time parameters noted in the Standard for Central-Station Alarm Services, UL 827.

40.6.5 Neither an integral nor a supplementary automatic printout is required if each individual protection system supervised by the multiplex system is provided with an individual display. A change in status shall be indicated automatically by the individual display affected.

40.6.6 The system shall continue to monitor the other systems while a status change is being recorded.

40.6.7 A signal that is repeated may be recorded only once, provided that the record indicates the nature of the signal.

40.6.8 Receipt of the signal shall require acknowledgment by the operator. Acknowledgment shall silence the audible signal and result in a visual display of the condition of the system.

Exception: In proprietary burglar alarm applications, acknowledgment is not required for a status change initiated by the operator at the proprietary station, however the initiation of the status change shall result in a visual display (at the proprietary station).

40.6.9 If no constant visual display is provided to indicate the condition of each protection system, a means shall be provided by which the monitoring station operator can determine the condition of any system at any time. A multiplex receiver used in conjunction with an automation system may be employed to determine the status of each system.

40.6.10 There shall not be loss or confusion of signals due to temporary outage of monitoring station equipment or outage of the connecting link between the monitoring station and the protection systems. The protection system, the satellite station, or the subsidiary station shall store information concerning any status change occurring during such an outage. Once the connection to the monitoring station has been re-established, all buffered signals shall be forwarded to the monitoring station.

40.6.11 The time lapse between the occurrence of a single break, single ground, wire-to-wire short, loss of signal, or any combination of these that can prevent the receipt of signals from the portion of the system affected by the fault, and the annunciation and recording of that condition at the monitoring station, shall not exceed 200 seconds from the time the fault is initiated. These faults shall be automatically recorded and the record shall identify each protective system and circuit affected. All changes in the status of the protective systems affected shall also be recorded when the fault is cleared.

Exception: If the protection system uses dual path transmission methods to the monitoring station, the time to annunciate and record a communication failure condition may be 6 minutes (360 seconds). Refer to 40.8.

40.6.12 The protective circuits shall be of the electrically-supervised type and arranged so as to initiate an alarm if the protective circuit is opened, if its conductors of opposite polarity are crossed, or if an initiating device in the circuit transfers to the alarm condition. The wiring between a zone expander and the control unit is considered a portion of the burglar alarm initiating protective circuit.

40.6.13 In a multiplex alarm system, the time lapse between the occurrence of a status change as indicated in 40.6.3 and the annunciation and recording of that change at the monitoring station shall not exceed 90 seconds from the time the fault is initiated. In this time interval, all supervised systems having more than 500 separate signals shall be scanned and the monitoring station shall be capable of annunciating and recording not less than 50 simultaneous status changes in the 90-second time interval. For systems having less than 500 separate signals, the monitoring station shall be capable of annunciating and recording not less than 10 percent of the total status change signals.

40.6.14 A subscriber's control unit shall transmit an alarm signal to the monitoring station if a circuit in the permanent protective wiring (24-hr zone) opens even when the premises is open and the system is disarmed.

40.6.15 A multiplex system shall give priority to signals in the order specified in (a) – (d), and shall annunciate subsequent signals at a rate of not less than one every 10 seconds. The order of priority of signals shall be:

a) Signal associated with life safety (fire alarm, carbon monoxide alarm, medical alarm);

b) Duress, holdup or panic alarm;

c) Burglar alarm;

d) Supervisory signals and trouble signals associated with life safety or security;

e) All other signals.

40.6.16 If a multiplex system does not annunciate signals in compliance with the order of priority specified in 40.6.15, signals shall be annunciated by separate means in such a way that the order of priority is maintained. A multiplex receiver provided with a constant connection to an automation system that has been evaluated in accordance with the requirements of the Standard for Central-Station Automation Systems, UL 1981, satisfies the intent of this requirement.

40.6.17 A multiplex system that incorporates more than five-hundred initiating device circuits, and does not give priority to signals, shall annunciate successive signals at a rate of 1 signal every 1.8 seconds or less (50 signals per 90 seconds). For systems with five-hundred or fewer initiating device circuits, the minimum number of signals annunciated every 90 seconds shall equal 10 percent of the total number of initiating devices in the system.

40.6.18 If multiplex system signals are transmitted directly from the protected systems to the monitoring station and the loss of the communication path prevents the receipt of signals from protective circuits beyond the fault, the number of separate signals on a single path shall be limited to 1000.

40.7 Packet switched data networks (PSDN)

40.7.1 As used in this standard, the term “packet switched data network (PSDN)” refers to transmission accomplished via Internet Protocol (IP), Global System for Mobile (GSM), General Packet Radio Service (GPRS), Code Division Multiple Access (CDMA), High Speed Packet Access (HSPA), Long-Term Evolution (LTE), and other equivalent technologies.

40.7.2 In addition to the applicable requirements for Multiplex Systems in 40.6, packet switched data networks shall comply with the requirements in this section.

40.7.3 Packet switched data network (PSDN) interface equipment, manufactured by other than the burglar alarm equipment manufacturer, that is not provided with the burglar alarm system and/or not required for the processing of the signals shall be evaluated to the applicable requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, as communication equipment. Any network interface device which adds value or manipulates the original data packet such as changing transmission formats, adding encryption, and the like, shall comply with the applicable requirements noted in this standard.

40.7.4 The connection to the network shall be of an "always on" or “on demand” nature and not require the use of the public switched telephone network to make a "dial up" connection. A loss of connection/signal shall be reported and identified within 200 seconds at the monitoring station receiving unit.

Exception: If the protection system utilizes dual path transmission methods in accordance with 40.8, the time to annunciate and record the communication failure condition may be extended to 6 min (360 s).

40.7.5 A single open, single earth ground, or wire-to-wire short on the packet switched data network circuit shall not affect the performance of the premises control unit except for the loss of the communication function extending from that circuit.

40.7.6 Supervision signals between premises alarm equipment and monitoring station alarm receiver equipment shall be managed by the monitoring station receiving equipment and not an intermediate station or intermediary network agent, device or service, unless investigated for such service as a monitoring station.

40.7.7 Neither panel nor receiver operating systems (software or firmware) shall be susceptible to known security breaches.

40.7.8 There shall be message authentication between the premises control unit and control receiving equipment:

a) Each message exchanged between the premises and monitoring station receiving equipment shall include the network address of the premises equipment, and a hashed (scrambled) key which is changed on every message exchange; or

b) A system shall be able to accommodate a minimum of 65,000 distinct account numbers. Message authentication shall consist of an account number plus an additional authentication key which is changed such that a compromise is detected in accordance with 40.14.

40.7.9 Network addressing of devices shall not make use of public domain name servers.

40.7.10 Signals between the premises control unit and the receiving equipment, when not carried by wireless means, shall be protected by one of the following methods:

a) The installation instructions shall state that the communication medium between protected property and communications service provider shall be for the exclusive use of the protected property and is not to be shared with other communications service provider subscribers; or

b) Each message sent between the premises control unit and the supervising station receiving equipment shall be protected with a cryptographic authentication means.

40.7.11 When the premises control unit uses a wireless RF link to a device at the point of demarcation for off premises transmission (wireless LAN or WAN) or directly to the receiver, the signals shall be encrypted.

40.7.12 The display and annunciation requirements for packet switched data network receivers shall comply with the requirements as indicated in this standard.

40.7.13 If there is no constant visual display provided to indicate each protective system, a means shall be provided by which the monitoring station operator can determine the condition of any system at any time. A packet switched data receiver used in conjunction with an automation system may be employed to determine the status of each system.

40.7.14 The alarm receiving equipment shall have a recording device of either a printer, magnetic medium, or other nonvolatile electronic memory capable of being viewed or printed.

40.8 Dual path transmission methods

40.8.1 Signals shall be transmitted by two or more of the following methods:

a) Code Transmitter (McCulloh) (see 40.3.1);

b) DACT (see 40.3.2):

1) PSTN;

2) Cellular;

3) MFVN (see 6.69).

c) One-Way Radio (see 40.4);

d) Two-Way Radio (see 40.5);

e) Multiplex (see 40.6);

f) Packet Switched Data Networks (PSDN) (see 40.7).

40.8.2 Each transmission path shall employ different methods of transmission technology, which pass through separate demarcation points, as they leave the protected property.

Exception: Both transmission paths may be Internet Protocol (IP), provided that each IP path employs a separate IP address and/or Internet Service Provider (ISP). Also see 40.8.8.

40.8.3 The specific transmission function indicated in 40.8.1 shall be provided as part of the product use marking. In addition, a system that meets the requirements of 40.8.5 and transmits alarm signals on both paths shall be marked for its function as a dual path transmission system. See 89.2(c).

40.8.4 A transmission method that does not provide an acknowledgment signal (see 40.13) shall not be used alone. An additional transmission method shall be required to provide an acknowledgment signal.

40.8.5 Loss of communication shall be annunciated at the monitoring station receiver within 200 seconds. If a fault is detected on any of the transmission paths, at least one of the transmission paths shall send a signal to the monitoring station to report the fault within 200 seconds.

Exception No. 1: The time to annunciate and record the communication failure condition may be extended to 6 minutes (360 seconds), if the following conditions are met:

a) A protection system that uses this method of communication supervision shall use two separate paths of transmission to the monitoring station.

b) Each transmission path shall supervise the other. Loss of either path of transmission shall be reported to the monitoring station within 6 minutes (360 seconds) over the operable path.

c) If one path is lost, communication supervision shall be maintained on the remaining path per the single path requirements for the technology used, until dual paths of transmission have been restored. See Table 40.1.

d) An alarm signal is sent to the monitoring station over both paths of transmission. For packet switched data networks, alarm signals do not have to be sent over both transmission paths if:

1) An alarm signal confirmation is sent from the monitoring station receiver to the protected premises over the primary path;

2) The alarm signal confirmation is received and annunciated at the protected premises within 20 seconds of being sent by the monitoring station receiver; and

3) The alarm signal confirmation procedure is documented in the product installation instructions.

e) The following individual faults on the antenna circuit on a One-Way or Two-Way Radio (RF) system that prevents communication to the monitoring station shall be annunciated at the monitoring station receiver within 200 seconds. A fault is defined as:

1) A single open;

2) A single earthground; or

3) A wire-to-wire short.

Exception No. 2: During the disarmed period, the time to annunciate and record the communication failure condition at the monitoring station may be extended to 60 minutes if Exception No. 1 and the following conditions are met:

a) The method used to detect and report the occurrence of a condition that can prevent the receipt of signals from the protection system and to annunciate that condition shall be applied at a statistically random rate. The minimum time between random checks shall be 5 minutes or less.

b) When armed, the system shall check that signals can be transmitted to the monitoring station. If the system cannot send a signal to the monitoring station, a signal to report the condition shall be transmitted to the monitoring station over the second path of transmission.

40.8.6 When an alarm system provides Standard Line Security or Encrypted Line Security on one of the paths, alarm signals shall be transmitted over that path. Opening (disarming) signals shall be transmitted immediately by either:

a) The method of transmission that provides Line Security; or

b) The method that does not provide Line Security. If the opening signal is not transmitted within five attempts, the opening signal, or a failure to communicate that signal, shall be transmitted over the method that provides Line Security.

40.8.7 When an alarm system does not provide Standard Line Security or Encrypted Line Security on either path, the system shall have the capability to transmit an alarm signal over both paths.

40.8.8 A dual line DACT shall be considered as a dual path transmission system if it meets the requirements of 40.8.5 and 40.8.7 and provides for a 24-hour check-in signal over one path. One path shall be a switched landline and the other shall be cellular.

40.8.9 In a dual path transmission system, individual faults on the antenna circuit on an RF system that prevents communication to the monitoring station shall be annunciated at the monitoring station receiver within 200 seconds. A fault is defined as:

a) A single open;

b) A single earthground; or

c) A wire-to-wire short.

40.8.10 A system may also employ an alternate primary path for off-premises communication. A dual path transmission system with an alternate primary path is one in which the alternate primary path provides the same level of integrity as the primary path and is brought into service before the next check-in/polling time interval should the primary path become inoperative. In addition, both the primary and the alternate primary paths shall be provided with the same level of Line Security (e.g. both have Standard Line Security, both have 128-bit Encrypted Line Security, both have 256-bit Encrypted Line Security).

40.8.11 The alternate primary path shall comply with all the applicable requirements in Section 40.

40.8.12 The time lapse between the occurrence of the faults described in 40.6.11 and the annunciation and recording of those conditions at the monitoring station shall not exceed the timings specified in Table 40.1 for the primary, alternate primary, and secondary paths.

40.9 Central/proprietary/police (monitoring) station units

40.9.1 Central/proprietary/police (monitoring) station receivers shall comply with the applicable requirements in this standard, and the Standard for Central-Station Alarm Services, UL 827, or the Outline of Investigation for Hosted Central Station Services, UL 827A. Software-based receiving equipment shall comply with Section 37.

40.9.2 The number of signals in each system used for burglar-alarm signals shall be limited to 1000. If applicable, this requirement shall be noted in the product installation instructions.

40.9.3 If the central/proprietary/police (monitoring) station equipment is completely duplicated with standby equipment, 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 to be considered unlimited.

40.9.4 The central/proprietary/police (monitoring) station equipment shall be designed and constructed so that any critical component can be replaced and the system restored to service within 30 minutes. This requirement shall be noted in the product installation instructions.

40.9.5 With reference to the requirement in 40.9.4, a critical component is one in which a malfunction will prevent the receipt and interpretation of signals by the monitoring station operator.

40.10 Automation system units

40.10.1 As used in these requirements, an automation system unit refers to monitoring station equipment that can automatically process routine signals, such as scheduled openings and closings, and record them. A signal requiring an operator's attention, such as an alarm signal, shall be recorded and both visually and audibly annunciated in a manner that identifies the source and type of signal for action.

40.10.2 Automation systems shall comply with the requirements in the Standard for Central-Station Automation Systems, UL 1981.

40.10.3 An automation system unit shall be completely duplicated and provision shall be made for switchover in a period of not more than 90 seconds, without loss of signal during this time. This requirement shall be noted on the product installation instructions.

Exception: If an automated system unit serves not more than one thousand active systems and not more than five thousand inactive systems, and uses manual backup equipment, duplication is not required. An active system is a system that transmits a signal to the monitoring station indicating that the system has been:

a) Opened and the alarm protection removed; and

b) Closed and the alarm protection set.

40.10.4 An inactive system is a system that transmits a signal to the monitoring station only when an unintended condition exists or it is under test. A holdup alarm system is considered inactive since it supervises protected circuits without the use of opening and closing signals.

40.11 Satellite/subsidiary stations

40.11.1 A satellite/subsidiary station shall be connected to a manned central-/proprietary/police (monitoring) station by two or more supervised channels, of which any can be used to operate the system.

40.11.2 If all of the channels between a satellite/subsidiary station and a manned monitoring station are inoperative, any signals received by the satellite/subsidiary station shall be automatically recorded or stored until the satellite/subsidiary station can be manned or the channels restored.

40.11.3 Signals received at the satellite/subsidiary station during the time that the channels are inoperative shall be transmitted to the monitoring station when operation is restored.

Exception: Transmission is not required if personnel manning the satellite/subsidiary station have cleared the signals.

40.11.4 A satellite/subsidiary station shall be equipped so that it can be manned and operated as a monitoring station, and as such shall also comply with the requirements of 40.9.

40.12 Private radio facilities

40.12.1 If a private radio carrier is used, the requirements in 40.12.1 – 40.12.10 shall apply.

40.12.2 Central, proprietary, police, satellite, or subsidiary stations shall be provided with dual transmitting and receiving equipment.

Exception: Remotely located equipment need not be duplicated unless six or more protection systems are dependent on it.

40.12.3 Each set of equipment in a dual-equipment installation shall be arranged so that either set can be used for operation of the system.

40.12.4 Switchover from the operating transmitter to the standby transmitter shall be accomplished in 30 seconds or less. The transfer shall be automatic, or capable of being affected manually by operating personnel.

40.12.5 Operating personnel shall be able to deactivate either transmitter independently of the other.

40.12.6 The dual receivers shall be energized at all times and provision shall be made for selection of a usable output from one of the two.

40.12.7 If the equipment is located in an unmanned area, the circuit extending between the monitoring station and the equipment shall be supervised to indicate to operating personnel that a fault has occurred.

40.12.8 Each transmitter and each receiver shall have its own antenna.

40.12.9 A visible display at the monitoring station shall, at all times, indicate the condition of each set. An audio-visual signal shall annunciate any malfunction that would prevent either set from operating.

40.12.10 The conditions specified in (a) – (d) shall be supervised at the monitoring station:

a) Transmitter in use (radiating).

b) Impaired operation of AC power supplying either the transmitting or receiving equipment.

c) Receiver malfunction.

d) Automatic switchover.

40.13 Acknowledgment signal

40.13.1 A system shall provide means for the monitoring station operator or equipment to send an acknowledgment signal to the subscriber to confirm that a normal closing signal has been received once the system has been armed. The premises control unit shall cause an audible or visual indication, or both, when it receives the acknowledgment signal transmitted from the monitoring station. Acknowledgment signal is also referred to as “ringback”.

Exception: In proprietary burglar alarm applications, acknowledgment is not required for a status change initiated by the operator at the proprietary station, however the initiation of the status change shall result in a visual display (at the proprietary station).

40.13.2 The acknowledgment signal may be sent manually or automatically.

40.13.3 The acknowledgment signal procedure shall be documented in the product installation instructions.

40.14 Standard line security equipment

40.14.1 Line security equipment utilizes a secure, end-to-end connection that guards against an attempt to compromise the connecting line or communication channel between the monitoring station and the protected premises.

40.14.2 As referred to in 40.14.3 (b) and (c), a compromise is the disconnection of the protected premises from the connecting line or communication channel in a manner that does not cause a signal at the monitoring station and therefore may allow entry into the protected premises without initiating a signal at the monitoring station. Equipment complying with the requirements in this section shall be identified as Standard Line Security equipment.

40.14.3 Standard Line Security equipment shall comply with the following:

a) Supervision – Opens, shorts, and ground faults on the communication channel between the protected premises and the monitoring station, either shall not adversely affect the intended operation of the end-to-end equipment, or shall be indicated by a trouble signal (disarmed state) or an alarm signal (armed state) at both the local premises and the monitoring station. As applicable, the electrical supervision requirements noted in Sections 40 and 41 shall be applied.

Exception: The local annunciation requirement noted above is not applicable to proprietary burglar alarm systems that are constantly monitored by the central supervisory station.

b) Equipment Compromise – The connecting line between the monitoring station and the protected premises control unit shall be supervised to automatically detect a compromise attempt within 6 minutes by the direct substitution of randomly selected equipment. Equipment used to make substitutions is to be identical in all aspects to the original equipment.

Exception No. 1: If a product has a unique digital signature, equipment compromise can be waived as applicable.

Exception No. 2: During the disarmed period, the time to detect a compromise may be longer than 6 minutes, but shall not be longer than 60 minutes, if (a) – (d) are all met:

a) The method used to detect and report a compromise attempt shall be applied at a statistically random rate. The minimum time of a random check for a compromise attempt shall be 5 minutes or less.

b) The system shall check for substitution of premises equipment when it is armed. If substitution has occurred, the system shall provide an alarm signal to the monitoring station. The check shall be made by some automatic means, such as an identifying code built into read-only memory, rather than relying on some action or acknowledgment by the user that an acknowledgment signal has been received from the monitoring station, indicating that the monitoring station/police station has received a normal closing signal.

c) A protection system that uses this method of checking for a compromise attempt shall use two methods of signal transmission to the monitoring station. Each method of signal transmission shall monitor the other and if either method of signal transmission becomes unable to transmit to the monitoring station, a signal shall be sent by the other, informing the monitoring station of the condition.

d) An alarm signal shall be sent to the monitoring station over both methods of signal transmission. Only one of the transmission methods need comply with the Line Security requirements, the other shall comply with the requirements of one of the methods of signal transmission of this standard.

c) Network Compromise – As applicable, the system shall be provided with minimum network security ensuring authorization of access to data within a network, to guard against such threats as: Denial of Service (DoS), spoofing, sniffing, hijacking, Trojans, viruses/worms, and malware. Software/hardware, a firewall, and/or a network intrusion detection system (NIDS) shall be provided as applicable and maintained with the latest updates, as supplied by the manufacturer.

d) Compatibility – As evaluated, the protected premises communicator(s) and the monitoring station receiver(s) determined to be compatible must be specifically described in the product installation instructions.

40.14.4 A compromise attempt as specified in 40.14.3 (b) and (c) shall cause a locked-in alarm signal that requires attention by monitoring station personnel.

40.14.5 An alarm signal caused by a compromise attempt need not be distinguished from a normal alarm signal.

40.14.6 If a number of systems depend on one signaling line or communication channel, the system against which a compromise attempt is made in accordance with 40.14.3 (b) and (c) shall be identified and the attempt shall not cause confusing signals that appear to originate in one of the other systems on that line or channel.

40.14.7 The compromise attempts described in 40.14.3 (b) and (c) are to be conducted at the protected premises at the end of the connecting line or communication channel, at terminals or a point located outside of the protected premises.

40.14.8 Equipment that meets the requirements for Standard Line Security shall be marked for its function as part of the product use marking. See 89.2(b).

40.15 Encrypted line security equipment

40.15.1 In addition to the Standard Line Security requirements of 40.14, Encrypted Line Security, 40.15, equipment shall utilize encryption algorithms with a minimum of 128 bits of security strength to provide data protection against a compromise attempt.

40.15.2 For products incorporating Encrypted Line Security, evidence of compliance for the validation of encryption algorithms (for example, Federal Information Processing Standards (FIPS), Specification for the Advanced Encryption Standard, FIPS 197) or validation of security requirements for cryptographic

modules (for example, FIPS 140-2, “Security Requirements for Cryptographic Modules”) with the National Institute of Standards and Technology (NIST) shall be provided.

40.15.3 A compromise attempt against a system provided with Encrypted Line Security equipment shall cause an audible and visual signal within 6 minutes that will require attention by monitoring station personnel. The signal shall be stored at the monitoring station after the signal is acknowledged in accordance with the requirements in the Standard for Central-Station Alarm Services, UL 827. Equipment complying with the requirements in this section shall be identified as Encrypted Line Security equipment.

40.15.4 Equipment that meets the requirements for Encrypted Line Security shall be marked for its function as part of the product use marking. See 89.2(b).

41 Electrical Supervision Test

41.1 The initiating and indicating device circuits of a burglar alarm unit shall be electrically supervised so that a distinctive visual or audible trouble signal will promptly indicate the occurrence of a single break (open), single ground fault, or wire-to-wire short, which would prevent the intended operation for alarm signals by the control unit. Prior to the application of a fault the unit shall be energized in the intended standby condition while connected to a rated source of voltage and frequency.

41.2 An initiating device circuit using radio frequency (RF) transmission is to be supervised in accordance with 69.10.1.

41.3 A malfunction or loss of primary power shall be shown by de-energization of an "AC power on" indicator, visible from the exterior of the product. The location and function of the indicator must be described in the product installation instructions and the component shall be marked in accordance with 89.1(p).

41.4 A malfunction of the power supply, or loss of either primary power or standby battery capability, shall result in an alarm or trouble signal.

41.5 An open, short, or ground fault in any circuit extending from a unit, other than the initiating and indicating device circuits, shall not affect the operation of the unit except for the loss of the function extending from that circuit.

Exception: If such a fault will affect the operation of the product, a trouble signal or alarm condition that will indicate the fault is required.

41.6 A single ground fault in any initiating or indicating device circuit, any circuit extending from the control unit, or interruption and restoration of any source of electrical energy connected to a control unit, shall not cause an alarm signal.

41.7 A fault condition (open, ground, or short) of other than a burglar alarm circuit of a combination control unit shall not affect the burglar-alarm signaling.

41.8 A trouble signal shall be distinctive from all alarm signals. In a combination system, both burglar alarm and non-burglar alarm circuits are not prohibited from using the same trouble signal.

41.9 If a silencing means, such as a switch, is provided to de-energize the audible trouble signal, actuation of the silencing means shall be indicated by a trouble light or equivalent visual indication.

41.10 For all equipment, any cover, door, access panel, or mounting means shall be electrically supervised if it gives access to any relays, terminals, controls, or related components that might be subject to tampering, so that opening or removal shall result in an alarm or trouble signal at the monitoring station.

Exception No. 1: This requirement does not apply to an enclosure located inside a completely protected safe or vault, or to equipment located at a monitoring station.

Exception No. 2: For power supplies and Local Burglar Alarm applications, annunciation of the tamper condition shall occur locally at the protected premises.

41.11 The mounting of a product located outside the protected area shall be electrically supervised so that removal of the device from its mounting surface shall result in an alarm or trouble signal at the monitoring station.

Exception: For power supplies and Local Burglar Alarm applications, annunciation of the tamper condition shall occur locally at the protected premises.

41.12 A control unit or terminal panel intended to be located outside of a complete vault or a complete safe shall be electrically protected so that an opening cannot be created of sufficient size to permit defeat of the system without resultant initiation of an alarm condition. A tamper device that will initiate an alarm if the unit is removed from its mounting surface is to be considered sufficient for the protection of the mounting surface side of the unit.

41.13 Openings in the enclosure shall not give access to any relays, terminals, controls, or related components that might be subject to tampering by hand or with hand tools, wires, hooks, and the like, without causing an alarm or trouble signal.

41.14 As applicable, the occurrence of any fault indicated in Section 41 shall be annunciated locally and/or at the monitoring station within a maximum of 90 seconds from the time the fault is initiated.

41.15 In addition to the requirements noted above, refer to Communication Operation, Section 40, for electrical supervision requirements for the off-premises communication circuit(s).

COMMON TESTS

42 Incorrect Connection Test

42.1 There shall be no internal damage to circuitry if field wiring terminals are shorted together or are connected to power supply terminals. See also 42.4.

42.2 A power source of rated voltage is to be connected between the terminal under test and ground. See 35.4.1.

42.3 There shall be no internal damage to circuitry if all connections to power terminals, input and output circuits, and off-premises communication terminals are reversed as pairs, reversed individually, or individually connected to any terminal adjacent to the one to which it is intended to be connected. See also 42.4.

42.4 If damage can result from incorrect connection, markings shall be provided, clearly visible to the installer during installation, that warn of consequences of improper connection. If correct polarity is required, polarity markings shall appear immediately adjacent to wiring terminals.

43 Input Measurement Test

43.1 With the product energized from rated voltage and connected to maximum rated load, the input to a product shall not exceed the marked current, power, or volt-ampere rating by more than 10 percent when the product is operated under all conditions of use.

43.2 The test voltage for this test is to be the maximum rated voltage for the product. For a product having a single voltage rating, such as 115 volts, maximum rated voltage is to be that single voltage. If the voltage is given in terms of a range of voltages, such as 110 – 120 volts, the maximum rated voltage is the highest value of the range.

44 Output Measurement Test

44.1 The measured voltage of all output circuits shall be within 85 and 110 percent of their marked rating under the following conditions:

a) With primary power connected and varied from 85 percent to 110 percent of rated voltage. If a standby battery is used, a fully charged battery shall be connected.

b) With primary power connected and varied from 85 percent to 110 percent of rated voltage. If a standby battery is used, it shall be disconnected.

c) If a standby battery is used, the product shall be tested with the primary power disconnected. The standby battery shall be replaced with a variable voltage filtered DC power supply and the voltage varied from 85 percent to 110 percent of rated battery voltage.

44.2 Measurements shall be made with no load or with the minimum load that is specified by the manufacturer. If more than one output circuit is provided, all circuits shall have no load connected to the minimum load that is specified by the manufacturer connected to each circuit.

44.3 Upon completion of 44.2, measurements shall then be made with the maximum load connected to the output circuit. If more than one output circuit is provided, all circuits shall have the maximum load connected. If connecting the maximum load to each output circuit will exceed the total output capacity of the product, the output circuit to be measured shall be loaded to its maximum rating and the other output circuits shall have their load adjusted so that the maximum total output capacity of the product is reached. This shall be repeated for each test.

44.4 Rated load is that value of resistive load which causes the rated current to flow when the load is connected to the output circuit and the input voltage to the product is adjusted to its rated voltage.

44.5 For power supplies, when the input voltage is adjusted to 110 percent of rated value, the output voltage (or voltages) of a product shall not be more than 130 percent of rated value with:

a) No load (open circuit); or

b) The minimum load specified by the manufacturer, connected to the output circuit (or circuits).

44.6 The measured voltages at the output circuits, with the minimum and maximum rated loads applied in turn, shall be compatible with the rating of the product intended to be connected to the circuit.

44.7 An output circuit that has a voltage deviation greater than permitted in 44.1 shall be identified in the product installation instructions as “special application”. In addition, the product installation instructions shall describe the manufacturer’s name and model designation of the specific device(s) intended to be powered by the non-regulated circuit that have been proven to be compatible at that same marked voltage rating or range.

44.8 The output circuits of a burglar alarm unit shall be power limited. See 6.19(c).

Exception: This requirement does not apply to an output circuit using a connecting device or other method recognized for high-voltage wiring, such as a 125 volt, 15 ampere, parallel blade receptacle.

45 Power-Limited Circuits Test

45.1 General

45.1.1 All field-wiring circuits that derive energy from power sources connected to a control unit shall be classified as a power-limited or non-power-limited circuit. A circuit shall be considered non-power-limited unless otherwise identified in the installation documentation and marking on the product. See 17.5 and 89.3.

45.1.2 The power source (or sources) supplying a power-limited circuit shall be either inherently limited requiring no overcurrent protection, or limited by a combination of a power source and overcurrent protection devices such that a power-limited circuit has electrical characteristics as described in Table 45.1 for AC circuits or Table 45.2 for DC circuits.

Table 45.1
Power Limitations for AC Circuits

Circuit voltage V_{max}[a]		Inherently limited power source (overcurrent protection not required)			Not inherently limited power source (overcurrent protection required)		
		0 – 20	over 20 – 30	over 30 – 100	0 – 20	over 20 – 100	over 100 – 150
Power limitations VA_{max}[b] (volt-amps)		–	–	–	250[d]	250	–
Current limitations I_{max}[c](amps)		8.0	8.0	$150/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	1.0
Maximum overcurrent protection (amps)		–	–	–	5.0	$100/V_{max}$	1.0
Power source maximum nameplate ratings	VA (volt-amps)	$5.0 \times V_{max}$	100	100	$5.0 \times V_{max}$	100	100
	Current (amps)	5.0	$100/V_{max}$	$100/V_{max}$	5.0	$100/V_{max}$	$100/V_{max}$

[a] V_{max} is the maximum output voltage regardless of load with rated input applied.

[b] VA_{max} is the maximum volt-ampere output after 1 minute of operation regardless of load and with overcurrent protection bypassed if used. A current-limiting impedance shall not be bypassed when determining I_{max} and VA_{max}.

[c] I_{max} is the maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed if used. If a transformer limits the output current, I_{max} limits apply after 1 minute of operation. If a current-limiting impedance (e.g. PTC), determined to be suitable for the purpose, is used in combination with a nonpower-limited transformer or a stored energy source, such as a storage battery to limit the output current, the limits apply after 5 seconds of operation.

[d] If the power source is a transformer, VA_{max} is 350 or less when V_{max} is 15 or less.

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Table 45.2
Power Limitations for DC Circuits

		Inherently limited power source (overcurrent protection not required)				Not inherently limited power source (overcurrent protection required)		
Circuit voltage V_{max} [a]		0 – 20	over 20 – 30	over 30 – 100	over 100 – 250	0 – 20	over 20 – 100	over 100 – 150
Power limitations VA_{max} [b] (volt-amps)		–	–	–	–	250[d]	250	–
Current limitations I_{max} [c] (amps)		8.0	8.0	$150/V_{max}$	0.030	$1000/V_{max}$	$1000/V_{max}$	1.0
Maximum overcurrent protection (amps)		–	–	–	–	5.0	$100/V_{max}$	1.0
Power source maximum nameplate ratings	VA (volt-amps)	$5.0 \times V_{max}$	100	100	$0.030 \times V_{max}$	$5.0 \times V_{max}$	100	100
	Current (amps)	5.0	$100/V_{max}$	$100/V_{max}$	0.030	5.0	$100/V_{max}$	$100/V_{max}$

[a] V_{max} is the maximum output voltage regardless of load with rated input applied.

[b] VA_{max} is the maximum volt-ampere output after 1 minute of operation regardless of load and with overcurrent protection bypassed if used. A current-limiting impedance shall not be bypassed when determining I_{max} and VA_{max}.

[c] I_{max} is the maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed if used. If a transformer limits the output current, I_{max} limits apply after 1 minute of operation. If a current-limiting impedance (e.g. PTC), determined to be suitable for the purpose, is used in combination with a nonpower-limited transformer or a stored energy source, such as a storage battery to limit the output current, I_{max} limits apply after 5 seconds of operation.

[d] If the power source is a transformer, VA_{max} is 350 or less when V_{max} is 15 or less.

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45.1.3 Relative to 45.1.2, acceptable means for current limiting include:

a) Transformer winding impedance;

b) Thermal link embedded within the winding overwrap of a transformer;

c) Circuit components (resistors, regulators, transistors, and similar devices) which comply with the temperature test under I_{max} condition; and

d) Suitable current-limiting impedances (positive temperature coefficient varistor, and the like).

45.1.4 Relative to 45.1.2, the following are not acceptable means of current-limiting:

a) Circuit component burnout;

b) Permanent or replaceable fuses;

c) Opening of conductors on printed-wiring boards; and

d) Opening of internal wiring conductors.

45.1.5 The overcurrent protection device specified in 45.1.2 shall be of the non-interchangeable type such that it cannot be renewed in the field with an overcurrent device having a higher current rating.

45.1.6 When conducting I_{max} and VA_{max} measurements, all overcurrent protection devices of the control unit are to be short-circuited. However, current-limiting devices are not to be bypassed and are to be allowed to remain functional.

45.1.7 Where the product contains a float battery charger, V_{max}, I_{max}, and VA_{max} measurements are to be conducted with both AC and battery connected to the product. If the product contains a battery transfer relay or contains a trickle charge battery circuit, measurements of V_{max}, I_{max}, and VA_{max} are to be conducted with the product first energized only from the AC power source and then repeated with the product energized solely from the battery. The battery used during these measurements is to have the largest capacity as specified in the manufacturer's installation document.

45.1.8 The loads referenced in 45.2.1 – 45.4.1 shall be resistive.

45.2 Maximum voltage

45.2.1 With the product energized only from its rated primary power source, the output voltage of the circuit under test is to be measured while the circuit is connected to full rated load and under open circuit conditions. The maximum voltage recorded under these two conditions is to be considered V_{max}. Where the product incorporates a secondary source of supply, the test is to be repeated with the product energized solely from the secondary power source and with the primary power source disconnected. The V_{max} value obtained from each power source is to be considered separately when applying the requirements of Table 45.1 or Table 45.2.

45.3 Maximum current

45.3.1 In order to determine compliance with the I_{max} limitation, a variable load resistor initially set to draw rated current is to be connected across the circuit. The current through the load resistor is to be noted and the load removed. The resistance of the load shall then be incrementally decreased, momentarily reconnected across the circuit while noting the current, and then removed. The method is to be repeated until a short-circuit condition is obtained. The load resistor is then to be readjusted to a value capable of producing and maintaining a current equal to the maximum permitted in Table 45.1 and Table 45.2. The load resistor is then to be connected to the circuit and the current through the load resistor measured after 1 minute or after 5 seconds as determined from Table 45.1 or Table 45.2.

45.3.2 The maximum current measurement is to be the rms value for circuits that are constantly energized and the peak value for circuits that pulse the output. The measurement of the time period starts when the output is initially energized with the load specified in 45.3.1, and continues until the current is continuously below the I_{max} value indicated in Table 45.1 or Table 45.2. The time period is to include any momentary period where the output current temporarily drops below the required I_{max} value limit.

45.3.3 Where a transformer limits the value of I_{max}, and when I_{max} cannot be maintained for 1 minute due to transformer burnout, a plot of current versus time is to be generated and the graph extrapolated to 1 minute. The results satisfy the requirement of the test when the extrapolated value of I_{max} at 1 minute does not exceed the I_{max} limitations as indicated in Table 45.1 or Table 45.2.

45.3.4 Where a transformer does not limit the current of I_{max}, and when the maximum current through the load resistor cannot be maintained for 5 seconds due to current-limiting devices (opening of thermal link power supply foldback, PTC varistor effect, and similar devices) the current load resistor shall be adjusted to a value which will produce a current just above the I_{max} value indicated in Table 45.1 or Table 45.2. The results are in compliance when the I_{max} value stated in Table 45.1 or Table 45.2 cannot be maintained for more than 5 seconds.

45.4 VA_{max} (not inherently limited circuits only)

45.4.1 In order to determine VA_{max}, the product is to be energized from a rated source of supply and the circuit under test open-circuited. A variable load resistor, initially set to draw rated circuit current, is then to be connected across the circuit, the circuit voltage and current recorded, and the load removed. The resistance of the load is then to be incrementally decreased, momentarily reconnected across the circuit

while recording the voltage and current, and then removed. This procedure is to be repeated until the load resistance has been reduced to a short circuit. Using the recorded voltage and current, the volt-ampere output under each load condition is to be calculated. The load resistor is then to be adjusted to that value which produced the maximum volt-ampere calculated and then connected to the circuit. After 1 minute, the voltage and current are again to be measured. The results of this test are acceptable if the calculated volt-ampere output of the circuit after 1 minute does not exceed the value specified in Table 45.1 or Table 45.2, as appropriate.

46 Undervoltage Operation Test

46.1 A burglar alarm unit shall operate for its intended signaling performance while energized at 85 percent of its rated voltage.

46.2 If a standby battery is used, the reduced voltage value is to be computed on the basis of the rated nominal battery voltage.

46.3 A product that uses batteries for principal power shall be tested for operation at 60 percent of nominal battery voltage if supplied by primary batteries, or 85 percent of nominal battery voltage if supplied by secondary batteries.

46.4 A product that uses primary or secondary batteries for standby power shall be tested for operation at 85 percent of nominal battery voltage while operating from standby power.

46.5 If the maximum impedance of an initiating device circuit extended from a product is required to be less than 100 ohms in order to obtain intended operation, maximum impedance is to be connected to the circuit during this test. If no impedance limitation is indicated in the installation instructions, an impedance of 100 ohms is to be used in the initiating device circuit.

47 Overvoltage Operation Test

47.1 A burglar alarm unit shall withstand 110 percent of its rated supply voltage without damage during the standby condition and shall operate for its intended signaling performance at the increased voltage.

47.2 A product that uses primary or secondary batteries for standby power shall be tested for operation at 110 percent of nominal battery voltage while operating from standby power.

47.3 The product is to be subjected to the increased voltage in the standby condition and then tested for its intended signaling performance. For this test, a 0-ohm line impedance shall be used in the initiating device circuit.

48 Variable Ambient Test

48.1 With the product energized from rated voltage and connected to maximum rated load, a burglar alarm unit shall function as intended at ambient temperatures of 0 and 49 °C (32 and 120 °F). The exposure to each of these temperatures shall be for a minimum of 4 hours.

Exception: A product intended for use in a monitoring station equipped with heating and air conditioning systems, and a secondary power supply to maintain the operation of these systems, may be exposed to temperatures of 13 and 35 °C (55 and 95 °F). The installation instructions of a product tested at these temperatures shall indicate these necessary conditions. See 89.1(r). These products need not comply with the requirements in the Humidity Test, Section 49, but shall comply with the requirements in the Leakage Current Test, Section 50, but without humidity conditioning. This exception does not apply to products that are intended to be used in a satellite station, a repeater station, or a protected premises.

48.2 For power supplies, following exposure to each of the temperatures in 48.1, the product shall comply with the requirements of the Undervoltage Operation and Overvoltage Operation Tests, Sections 46 and 47.

49 Humidity Test

49.1 With the product energized from rated voltage and connected to maximum rated load, a burglar alarm unit shall function as intended during and after an exposure of 24 hours to air having a relative humidity of 85 ±5 percent and a temperature of 30 ±2 °C (86 ±3 °F).

49.2 Cord-connected products powered from a high-voltage source shall comply with the applicable requirements in the Leakage Current Test, Section 50, immediately following exposure to the environment specified in 49.1.

49.3 For power supplies, following the exposure in 49.1, the product shall comply with the requirements of the Undervoltage Operation and Overvoltage Operation Tests, Sections 46 and 47.

50 Leakage Current Test

50.1 Where a cord-connected product is powered by a source greater than 42.4 V peak, the leakage current at any exposed surface, or between any accessible part and earth ground, or any other accessible part with an open potential of greater than 42.4 V peak shall not be more than the values shown in Table 50.1 when tested in accordance with 50.2 – 50.8, immediately after exposure to the Humidity Test, Section 49.

Table 50.1
Maximum Leakage Current

Type of product[a]	Maximum leakage current,[b] mA
2-wire cord-connected portable or stationary product	0.50
3-wire (including grounding conductor) cord-connected portable product	0.50
3-wire (including grounding conductor) cord-connected stationary or fixed product	0.75

[a] Products which incorporate a loss-of-ground detector which dependably opens the live conductors are exempted from the requirements in this table.

[b] If an electromagnetic radiation suppression filter is necessary for the equipment to function as intended, the leakage current shall not be more than 2.5 milliamperes if the equipment complies with the following conditions:

1. The equipment is provided with grounding means in accordance with the applicable requirements for cord-connected equipment in Section 15.

2. With the filter removed from the equipment, the leakage current does not exceed the limits specified in this table, as applicable.

3. The equipment is marked in accordance with 89.15.

50.2 With regard to the requirements in 50.1, leakage current refers to all currents, including capacitively coupled currents that are capable of being conveyed between exposed conductive surfaces of the equipment and ground, or between exposed conductive surfaces of the equipment.

50.3 Leakage currents from all exposed surfaces are to be measured to the grounded supply conductor individually as well as collectively where exposed surfaces are simultaneously accessible, and from one exposed surface to another where the exposed surfaces are simultaneously accessible. A part is considered to be an exposed surface unless it is guarded by an enclosure determined to protect against the risk of electric shock. Surfaces that can be readily contacted by one or both hands of a person at the same time are determined to be simultaneously accessible. For the purpose of these requirements, one

hand is determined to be able to contact parts simultaneously when the parts are within a 4 by 8 inches (102 by 203 mm) rectangle, and two hands of a person are determined to be able to contact parts simultaneously when the parts are no more than 6 feet (1.8 m) apart.

50.4 Where a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil having dimensions of 3.94 by 7.88 inches (10 by 20 cm) in contact with the surface. Where the surface is less than 3.94 by 7.88 inches (10 by 20 cm), the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the product.

50.5 The measurement circuit for the leakage current test is to be as illustrated in Figure 50.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement need only indicate the same numerical value for the particular measurement as would the defined instrument. The meter is not required to have all of the attributes of the defined instrument:

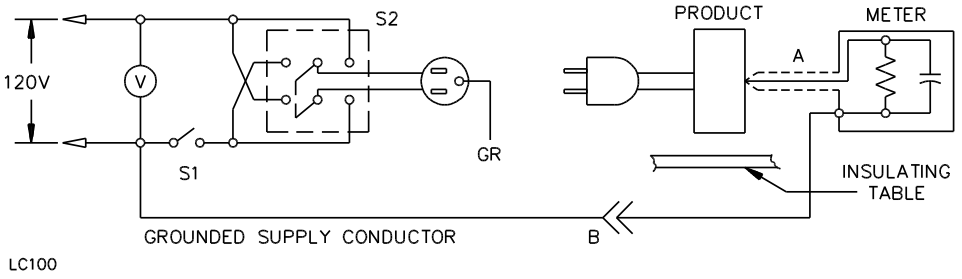
a) The meter is to have an input impedance of 1500 W resistive shunted by a capacitance of 0.15 µF;

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor;

c) Over a frequency range of 0 – 100 kHz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500-W resistor shunted by a 0.15 µF capacitor to 1500 W. At an indication of 0.5 or 0.75 mA, the measurement is to have an error of not more than 5 % at 60 Hz.

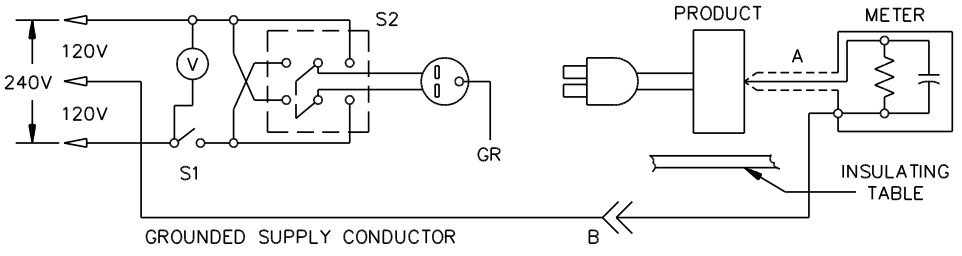
Figure 50.1

Leakage Current Measurement Circuits



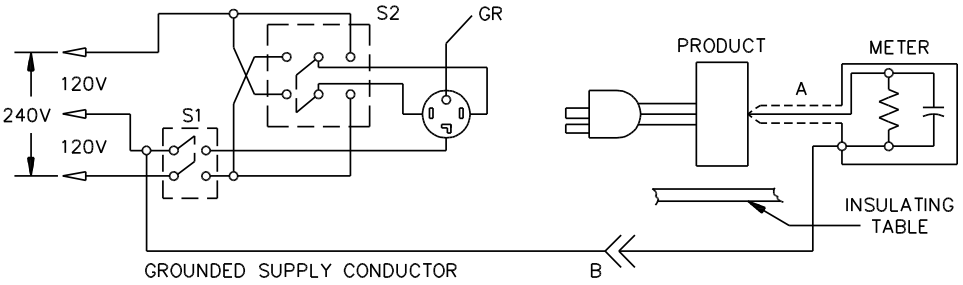
LC100

Product intended for connection to a 120-V power supply, as illustrated above.



LC200

Product intended for connection to a 3-wire, grounded neutral 120/240-V power supply, as illustrated above.



LC300

Product intended for connection to a 3-wire, grounded neutral 120/240-V power supply, as illustrated above.

A – Probe with shielded lead. Under some circumstances where higher frequency components are present, shielding of measuring instrument and its leads may be necessary.

B – Separated and used as clip when measuring currents from one part of a product to another.

NOTE – 120/240 V circuit also applies to 208/240 V supply.

50.6 Unless the meter is being used to measure the leakage current from one part of a product to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

50.7 Systems of interconnected equipment with individual connections to primary power shall have each piece of equipment tested separately. Systems of interconnected equipment with one common connection to primary power shall be treated as a single piece of equipment. Equipment designed for multiple (redundant) supplies shall be tested with only one supply connected.

50.8 A sample of the product is to be tested in the as-received condition initially with all switches indicated below closed, but with its grounding conductor, when provided, open at the attachment plug. A product that has not been energized for a minimum of 48 hr prior to the test, and that is at room temperature, is determined to be in the as-received condition. The supply voltage is to be the maximum voltage marked on the product, in accordance with 35.4.1, but not less than 120 or 240 V. The test sequence (with regard to Figure 50.1) is to be as follows:

a) With switch S1 open, the product is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, and with the product switching devices in all of their normal operating positions;

b) Switch S1 is then to be closed, energizing the product, and within 5 s the leakage current is to be measured using both positions of switch S2 and with the product switching devices in all their normal operating positions;

c) Leakage current is to be monitored until thermal stabilization occurs. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation of the product as in the Temperature Test, Section 56.

51 Electric Shock Current Test

51.1 If the open circuit potential between any part that is exposed only during operator servicing and either earth ground, or any other exposed accessible part exceeds 42.4 volts peak, the part shall comply with the requirements in 51.2 – 51.4, as applicable.

51.2 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 51.1 when the resistor is connected between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part.

51.3 The duration of a transient current flowing through a 500-ohm resistor connected as described in 51.2 shall not exceed:

a) The value determined by the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I} \right)^{1.43}$$

in which:

T is the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 mA and the time that the current falls below 7.1 mA for the last time; and

I is the peak current in milliamperes; and

b) 809 mA, regardless of duration.

The interval between occurrences shall be equal to or greater than 60 seconds if the current is repetitive. Typical calculated values of maximum transient current duration are shown in Table 51.2.

Table 51.1
Maximum Current during Servicing

Frequency, hertz[a]	Maximum current through a 500-ohm resistor, mA peak
0 – 100	7.1
500	9.4
1,000	11.0
2,000	14.1
3,000	17.3
4,000	19.6
5,000	22.0
6,000	25.1
7,000 or more	27.5

[a] Linear interpolation between adjacent values may be used to determine the maximum current corresponding to frequencies not shown. The table applies to repetitive nonsinusoidal or sinusoidal waveforms.

51.4 The maximum capacitance between the terminals of a capacitor during operator servicing shall comply with the following equations:

$$C = \frac{88,400}{E^{1.43}(In\ \ E - 1.26)} \quad for\ \ 42.4 \le E \le 400$$

$$C = 35,288E^{-1.5364} \quad for\ \ 400 \le E \le 1000$$

in which:

C is the maximum capacitance of the capacitor in microfarads; and

E is the potential in volts across the capacitor prior to discharge.

E is to be measured 5 seconds after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like. Typical calculated values of maximum capacitance are shown in Table 51.3.

Table 51.2
Maximum Transient Current

Maximum peak current (I) through 500-ohm resistor, mA	Maximum duration (T) of waveform containing excursions greater than 7.1 mA peak
7.1	7.26 seconds
8.5	5.58
10.0	4.42
12.5	3.21
15.0	2.48
17.5	1.99

Table 51.2 Continued on Next Page

Table 51.2 Continued

Maximum peak current (I) through 500-ohm resistor, mA	Maximum duration (T) of waveform containing excursions greater than 7.1 mA peak
20.0	1.64
22.5	1.39
25.0	1.19
30.0	919 milliseconds
40.0	609
50.0	443
60.0	341
70.0	274
80.0	226
90.0	191
100.0	164
150.0	92
200.0	61
250.0	44
300.0	34
350.0	27
400.0	23
450.0	19
500.0	16
600.0	12
700.0	10
809.0	8.3

Table 51.3
Electric Shock – Stored Energy

Potential across capacitance prior to discharge, volts	Maximum capacitance, microfarads
1000	0.868
900	1.02
800	1.22
700	1.50
600	1.90
500	2.52
400	3.55
380	3.86
360	4.22
340	4.64
320	5.13
300	5.71
280	6.40
260	7.24
240	8.27
220	9.56
200	11.2

Table 51.3 Continued on Next Page

Table 51.3 Continued

Potential across capacitance prior to discharge, volts	Maximum capacitance, microfarads
180	13.4
160	16.3
140	20.5
120	26.6
100	36.5
90	43.8
80	53.8
70	68.0
60	89.4
50	124.0
45	150.0
42.2	169.0

51.5 With reference to the requirements in 51.2 and 51.3, the current is to be measured while the resistor is connected between ground and:

a) Each accessible part individually;

b) All accessible parts collectively if the parts are simultaneously accessible.

The current also is to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

51.6 With reference to the requirements in 51.5, parts are considered to be simultaneously accessible if they can be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is considered to be able to contact parts simultaneously if the parts are within a 4- by 8-inch (102- by 203-mm) rectangle, and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 6 feet (1.8 m) apart.

51.7 Electric shock current refers to all currents, including capacitively coupled currents.

51.8 If the product has a direct-current rating, measurements are to be made with the product connected in turn to each side of a 3-wire, direct current supply circuit.

51.9 Current measurements are to be made:

a) With any operating control, or adjustable control that is subject to user operation, in all operating positions; and

b) Either with or without a vacuum tube, separable connector, or similar component in place.

These measurements are to be made with controls placed in the position that causes maximum current flow.

52 Overload Test

52.1 General

52.1.1 A burglar alarm unit other than that operating from a primary battery shall operate as intended after 50 cycles of operation at a rate of not more than 15 cycles per minute while connected to a source of

supply adjusted to 115 percent of rated voltage. Each cycle is to begin with the product energized in the standby condition, followed by intended operation, and then restoration to standby condition.

52.1.2 Rated test loads are to be connected to the output circuits of the product. The test loads are to be remote indicators, relays, or the equivalent. If an equivalent load is used to simulate an inductive component, a power factor of 60 percent is to be used. The rated loads are to be established with the product initially connected to a source of supply in accordance with the requirements of 35.4.1 following which the voltage is to be increased to 115 percent of the initial value.

52.1.3 For DC circuits, an equivalent inductive test load shall have the:

a) Required DC resistance for the test current; and

b) Inductance (calibrated) necessary to obtain a power factor of 60 percent when connected to a 60-Hertz AC rms voltage equal to the rated DC test voltage.

The resultant AC current shall be equal to 60 percent of the DC current when the load is connected first to an AC voltage and then to a DC voltage equal to the rms value of the AC source.

52.2 Separately energized circuits

52.2.1 Separately energized circuits that do not receive energy from the product (e.g. dry-contact relays), such as dry contacts, shall operate as intended after 50 cycles of signal operation at a rate of not more than 15 cycles per minute while connected to a voltage source in accordance with the requirements of 35.4.1 and with 150 percent rated current loads at 60 percent power factor applied to the output circuits.

52.2.2 The test loads shall be adjusted to draw 150 percent of their rated current while connected to a separate source of supply in accordance with 35.4.1.

52.3 Power supplies

52.3.1 The power supply shall operate as intended following 50 cycles of operation as described in 52.3.2.

52.3.2 With the input connected to a voltage source of 115 percent of the appropriate value specified in 35.4.1, a load(s) drawing 150 percent of maximum rated output power is to be applied, then removed (or reduced to the manufacturer's specified minimum value) at the rate of not more than 15 cycles per minute, where each cycle consists of the load(s) application followed by an equal time of the load(s) removal (or reduction).

52.3.3 A power supply for use with a grounded supply circuit is to be tested with the enclosure and all other normally grounded parts connected through a 15-ampere fuse to the grounded conductor of the supply circuit.

52.3.4 At the conclusion of this test, there shall have been no electrical or mechanical malfunction of any components, as evidenced by compliance with the requirements of the Undervoltage Operation and Overvoltage Operations Tests, Sections 46 and 47.

53 Endurance Test

53.1 General

53.1.1 A burglar alarm unit shall operate at rated voltage with rated devices or equivalent maximum load connected to the output circuits for the number of cycles indicated in Table 53.1. Each cycle shall consist

of starting with the product in the normal standby condition, actuating for alarm, and returning to the normal standby condition. The rate of operation shall:

a) Not be more than 15 cycles per minute or the product's rated speed of operation, whichever is faster, for a product designed to operate repeatedly; or

b) Be 2 pulses per second for a product receiving a signal from a code. transmitter.

At the completion of the test, the product shall be mechanically and electrically operable, shall perform its intended function, and shall not show manifestation of fire or risk of electric shock.

Table 53.1
Cycles of Operation

Product	Number of cycles
Control units and accessories	6,000
Police station connected and local burglar alarm units	See 53.2
Power supplies	2,000
Holdup alarm units	2,000
Digital alarm communicator transmitter (DACT)	6,000
Central (monitoring) station receivers (e.g. DACR, Multiplex)	30,000
Code transmitter (McCulloh) receiving unit and register	500,000 pulses
Alarm printer	500,000 lines

53.2 Police station connected and local burglar alarm units

53.2.1 A product intended to be operated one to five times a day shall operate at test voltage for 6000 cycles of intended operation.

53.2.2 A product intended to be operated six or more times a day shall operate at test voltage for 50,000 cycles of intended operation.

53.2.3 A product that operates only when it is required to perform its function shall operate at test voltage for 1000 cycles of intended operation.

53.2.4 The device may be cycled at any rate up to 15 cycles per minute.

53.3 Power supplies

53.3.1 The product shall operate as intended following 2000 cycles of operation as described in 53.3.2.

53.3.2 With the input connected to a voltage source in accordance with 35.4.1, a load(s) drawing maximum rated output power is to be alternately applied then removed (or reduced to the manufacturer's specified minimum value) at the rate of not more than 15 cycles per minute, where each cycle consists of the load(s) application followed by an equal time of the load(s) removal (or reduction).

53.3.3 At the conclusion of this test, there shall have been no electrical or mechanical malfunction of any components, as evidenced by compliance with the requirements of the Undervoltage Operation and Overvoltage Operations Tests, Sections 46 and 47.

53.4 Integral operating devices

53.4.1 An operating device supplied as a part of a product (such as a power/tamper switch, wet-contact relay, or motor), shall perform as intended when operated for the number of cycles and at the rate indicated for the application noted in Table 53.1. When an electrical load is involved, the contacts of the device are to make and break the normal current at the rated voltage. The load is to represent that which the device is intended to control or an equivalent load consistent with 53.5.1. The endurance tests of these devices may be conducted in conjunction with the endurance test on a product.

Exception No. 1: This requirement does not apply when the circuit controlled has a power factor less than 75 %, and the integral operating device employs the following ratings:

a) A horsepower rating (evaluated on the basis of the ampere equivalent); or

b) A current rating of not less than 200 % of the maximum load current.

Exception No. 2: This requirement does not apply to components previously investigated for endurance cycling at full rated load during evaluation to the UL component standards noted in Appendix A.

53.5 Separately energized circuits

53.5.1 Separately energized circuits that do not receive energy from the product (e.g. dry-contact relays) shall operate as intended following the applicable Endurance Test cycles as specified in Table 53.1 while connected to a source of supply in accordance with 35.4.1 and with rated load at 60 percent power factor applied to output circuits.

Exception: This requirement does not apply to components previously investigated for endurance cycling at full rated load during evaluation to the UL component standards noted in Appendix A.

54 Jarring Test

54.1 A burglar alarm unit shall withstand jarring resulting from impact and vibration anticipated in the intended application without:

a) Resulting in a fire hazard or risk of electric shock;

b) Causing false operation of any part; and

c) Impairing its subsequent intended operation, as evidenced by compliance with the requirements in the Normal Operation Test, Section 39.

54.2 For power supplies, following the jarring the product shall comply with the requirements of the Undervoltage Operation and Overvoltage Operations Tests, Sections 46 and 47.

54.3 Product utilizing freestanding, or other non-wall- or ceiling-type mounting shall comply with the requirements in 54.1 when subjected to the jarring described in 54.5. Desktop products shall comply with the requirements in 54.1 when subjected to the conditions described in 54.7.

54.4 Products weighing less than 30 lbs (13.6 kg) and utilizing wall or ceiling mount configurations shall comply with the requirements in 54.1 when subjected to the jarring described in 54.6. Products weighing 30 lbs (13.6 kg) or more and utilizing wall or ceiling mount configurations shall comply with the requirements in 54.1 when subjected to the jarring described in either 54.5 or 54.6. The direct impact shall be applied to the center of the side of the product intended to be adjacent to the mounting surface during intended mounting.

54.5 An impact of 4.08 J (3 ft·lb) is to be applied directly to any non-display area of the product by means of a 1.18-lb (0.54 kg), 2-inch (51-mm) diameter steel sphere swung through a pendulum arc from a height (h) of 30.5 inches (775 mm). The at-rest suspension point of the steel sphere is to be 1-inch (25.4-mm) in front of the plane of the product to be impacted.

54.6 The product and associated equipment is to be mounted as intended to the center of a 6 by 4 foot (1.8 by 1.2 m), nominal 3/4 inch (19.1 mm) thick plywood board that is secured in place at four corners. A 4.08 J (3 ft-lb) impact is to be applied to the center of the reverse side of this board by means of a 1.18-lb (0.54 kg), 2 inch (50.8 mm) diameter steel sphere either:

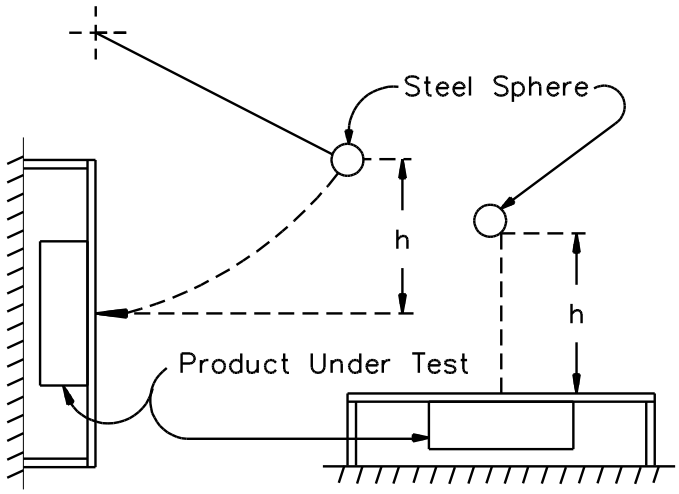
a) Swung through a pendulum arc from a height (h) of 30.5 inches (775 mm); or

b) Dropped from the height (h) of 30.5 inches (775 mm), depending upon the mounting of the equipment.

See Figure 54.1.

Figure 54.1

Jarring Test



54.7 Products intended to be mounted on a desktop shall be permitted provided both of the following conditions are met:

a) The product is supervised such that a tamper event/signal is annunciated when it is displaced from the mounting position; and

b) The product operates as intended after being dropped four consecutive times onto a hardwood floor from a height of 775 mm. If the sample has corners, it is to be dropped on a different corner each time, selecting the four corners that appear to be most susceptible to damage. If the product

has no corners, it is to be dropped on the four portions that appear to be most susceptible to damage. Reassembly without the use of tools is allowed provided no permanent damage has occurred.

54.8 During this test, the unit is to be operated in the normal standby condition and connected to a rated source of supply in accordance with the requirements in 35.4.1.

55 Dielectric Voltage-Withstand Test

55.1 A product shall withstand for 1 minute without breakdown the application of an essentially sinusoidal AC potential of a frequency within the range of 40 – 70 Hertz, or a DC potential, between live parts and the enclosure, live parts and exposed dead metal parts, and live parts of circuits operating at different potentials or frequencies. The test potential is to be (also, see 55.3):

a) For circuits rated 30 V AC rms (42.4 V DC or AC peak) or less – 500 V AC (707 V, when a DC potential is used);

Exception: This test can be waived for low-voltage, power-limited circuits.

b) For circuits rated greater than 30 and equal to or less than 150 V AC rms (42.4 and 212 V DC) – 1000 V AC (1414 V, when a DC potential is used);

c) For circuits rated more than 150 V AC rms (212 V DC) – 1000 V AC plus twice the rated voltage (1414 plus 2.828 times the rated AC rms voltage, when a DC potential is used).

55.2 Exposed dead-metal parts are non-current-carrying metal parts that are capable of becoming energized and are accessible from outside of the enclosure of a product.

55.3 For the application of a potential between live parts of circuits operating at different potentials or frequencies, the voltage is to be the applicable value specified in 55.1 (a), (b), or (c), based on the highest voltage of the circuits under test instead of the rated voltage of the product. Electrical connections between the circuits are to be disconnected before the test potential is applied.

55.4 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an AC test potential in accordance with 55.1 (c) is to be applied directly to all wiring involving more than 150 volts.

55.5 If the charging current through a capacitor or capacitor type filter connected across the line, or from line to earth ground, is sufficient to prevent maintaining the specified AC test potential, the capacitor or filter is to be tested using a DC test potential in accordance with 55.1.

55.6 The test potential may be obtained from any convenient source having sufficient capacity to maintain the specified voltage. The output voltage of the test apparatus is to be monitored. The method of applying the test voltage is to be such that there are no transient voltages that result in instantaneous voltage being applied to the circuit exceeding 105 % of the peak value of the specified test voltage. The applied potential is to be:

a) Increased from 0 at a uniform rate so as to arrive at the specified test potential in approximately 5 s; and then

b) Maintained at the test potential for 1 min without an indication of a breakdown.

Manual or automatic control of the rate of rise is not prohibited.

55.7 A printed wiring assembly or other electronic circuit component that would be damaged by the application of, or would short-circuit, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the dielectric voltage-withstand tests are made. A representative subassembly may be tested instead of an entire unit. Rectifier diodes in the power supply may be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

55.8 A printed-wiring board, as specified in 34.1, shall withstand for 1 min without breakdown the application of a dielectric withstand potential between the traces having reduced spacings, in accordance with 55.1, as appropriate.

55.9 As specified in 55.8, power-dissipating component parts, electronic devices, and capacitors connected between traces having reduced spacings, are to be removed or disconnected so that the spacings and insulations, rather than these component parts, are subjected to the full dielectric voltage-withstand test potential.

56 Temperature Test

56.1 The materials used in the construction of a burglar alarm unit shall not attain temperature rises greater than those indicated in Table 56.1.

Table 56.1
Maximum Temperature Rises

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
A. COMPONENTS				
1. Capacitors: [a,b]				
a. Electrolytic types	25	(45)	40	(72)
b. Other types	25	(45)	65	(117)
2. Rectifiers – At any point				
a. Germanium	25	(45)	50	(90)
b. Selenium	25	(45)	50	(90)
c. Silicon	50	(90)	50	(90)
3. Relay, solenoid, transformer, and other coils with:				
a. Class 105 (formerly Class A) insulation system:				
Thermocouple method	65	(117)	65	(117)
Resistance method	85	(153)	85	(153)
b. Class 130 (formerly Class B) insulation system:				
Thermocouple method	85	(153)	85	(153)
Resistance method	105	(189)	105	(189)
c. Class 155 insulation system:				
(i) Class 2 transformers:				
Thermocouple method	95	(171)	95	(171)
Resistance method	115	(207)	115	(207)
(ii) Power transformers:				

Table 56.1 Continued on Next Page

Table 56.1 Continued

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
Thermocouple method	110	(198)	110	(198)
Resistance method	120	(216)	120	(216)
d. Class 180 insulation system:				
(i) Class 2 transformers:				
Thermocouple method	115	(207)	115	(207)
Resistance method	135	(243)	135	(243)
(ii) Power transformers:				
Thermocouple method	125	(225)	125	(225)
Resistance method	135	(243)	135	(243)
4. Resistors: [c]				
a. Carbon	25	(45)	50	(90)
b. Wire wound	50	(90)	125	(225)
c. Other	25	(45)	50	(90)
5. Solid state devices	See footnote d.			
6. Other components and materials:				
a. Fiber used as electrical insulation or cord bushings	65	(117)	65	(117)
b. Varnished cloth insulation	60	(108)	60	(108)
c. Thermoplastic materials	Rise based on temperature limit of the material			
d. Phenolic composition used as electrical insulation or as parts whose malfunction or deterioration may result in a risk of electric shock, explosion, fire, or injury to persons[e]	125	(117)	125	(225)
e. Wood or other combustibles	65	(117)	65	(117)
f. Sealing compound	22 °C (72 °F) less than the melting point of the compound			
g. Fuses				
i) Class G, J, L, and CC:				
Tube	100	(180)	100	(180)
Ferrule or blade	85	(153)	85	(153)
ii) Others	65	(117)	65	(117)
B. CONDUCTORS				
1. Appliance wiring material[f]	25 °C (77 °F) less than the temperature limit of the wire			
2. Flexible cord (for example, SJO, SJT)	35	(63)	35	(63)
3. Conductors of field-wired circuits to be permanently connected to the product	35	(63)	35	(63)
C. GENERAL				
1. All surfaces of the product and surfaces adjacent to or upon which the product may be mounted	65	(117)	65	(117)
2. Surfaces normally contacted by the user in operating the unit (control knobs, push buttons, levers, and the like):				
a. Metal	35	(63)	35	(63)
b. Nonmetallic	60	(108)	60	(108)

Table 56.1 Continued on Next Page

Table 56.1 Continued

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
3. Surfaces subjected to casual contact by the user (enclosure, grille, and the like):				
a. Metal	45	(81)	45	(81)
b. Nonmetallic	70	(126)	70	(126)
4. Printed-wiring board	See footnote g.			

[a] For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure shall not be more than 65 °C (117 °F).

[b] A capacitor may be evaluated on the basis of its marked temperature rating , or with component reliability data based on actual performance in a similar application or the Military Handbook “Electronic Reliability Design Handbook, MIL-HDBK-338”, or equivalent (such as RIAC 217Plus) such that the failure rate is equal to or less than 0.5 failures per million hours of operation.

[c] The temperature rise of a resistor may exceed the values shown if the power dissipation is 50 percent or less of the manufacturer's rating , or with component reliability data based on actual performance in a similar application or the Military Handbook “Electronic Reliability Design Handbook, MIL-HDBK-338”, or equivalent (such as RIAC 217Plus) such that the failure rate is equal to or less than 0.5 failures per million hours of operation.

[d] The temperature of a solid-state device (for example, transistor, SCR, integrated circuits), shall not exceed 50 percent of its rating during the normal standby condition. The temperature of a solid-state device shall not exceed 75 percent of its rated temperature under the alarm condition or any other condition of operation which produces the maximum temperature dissipation of its components. For reference purposes 0 °C (32 °F) shall be considered as 0 percent. For integrated circuits the loading factor shall not exceed 50 percent of its rating under the normal standby condition and 75 percent under any other condition of operation.

In lieu of the above, both solid-state devices and integrated circuits may be operated up to 100 % of their rating under any condition of normal use if the components are subjected to one of the following:

1. For integrated circuits, the component complies with the requirements of the Test Method Standard for Microcircuits, MIL-STD 883H. For all other solid state devices (such as diodes, transistors, SCR's, LEDs) the component complies with the requirements of the Standard for Test Methods for Semiconductor Devices, MIL-STD-750F.

2. A quality-control program is established by the manufacturer consisting of inspection and stress testing of all pertinent parameters of 100 % of all components, either on an individual basis, as part of a subassembly, or equivalent.

3. Each assembled production unit is subjected to a burn-in test, under the condition which results in the maximum temperatures, for 24 hours while connected to a source of rated voltage and frequency in an ambient of at least 49 °C (120 °F), followed by an operational test.

4. Component reliability data based on actual performance in a similar application, or the Military Handbook "Electronic Reliability Design Handbook, MIL-HDBK-338" or equivalent (such as RIAC 217Plus), such that the failure rate is equal to or less than 0.5 failures per million hours of operation.

5. The component complies with the requirements for a benign environment in Table 3.14-3 of the Electronic Derating for Optimum Performance, RIAC (Reliability Information Analysis Center), dated November 15, 2006.

[e] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds which have been investigated and determined to meet the requirements for use at higher temperatures.

[f] For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code, ANSI/NFPA 70, the maximum allowable temperature rise in any case is 25 °C (77 °F) less than the temperature rating of the wire in question.

[g] Temperatures on the surface of any printed-wiring board shall not exceed the temperature limits of the printed-wiring board material.

56.2 The temperature values in Table 56.1 are based on an assumed ambient temperature of 25 ±15 °C (77 ±27 °F), and tests are to be conducted at an ambient temperature within that range. When equipment is intended specifically for use with a prevailing ambient temperature constantly more than 25 °C (77 °F), the test of the product is to be made with the higher ambient temperature, and the allowable temperature rises specified in Table 56.1 are to be reduced by the amount of the difference between that higher ambient temperature and 25 °C (77 °F).

56.3 As applicable, the Temperature Test is to be performed in conjunction with the Power Failure Test (Section 57) to measure worst-case heat dissipation for components in charging and discharging circuitry.

56.4 Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) or by the change-in-resistance method, except that the thermocouple method is not to be used for a temperature measurement at any point where thermal insulation is used.

56.5 Thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and an infrared temperature probe of the equivalent shall be used whenever referee temperature measurements by thermocouples are necessary.

56.6 The temperature of a coil winding may be determined by the change-in-resistance method, wherein resistance of the winding at the temperature to be determined is compared with the resistance at a known temperature, by means of the equation:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

Δt is the temperature rise in degrees C;

R is the resistance in ohms at end of test;

r is the resistance in ohms at start of test;

k is 234.5 for copper or 225.0 for electrical conductor grade aluminum;

t_1 is the room temperature at start of test, in degrees C; and

t_2 is the room temperature at end of test, in degrees C.

56.7 To determine compliance with these requirements, the product is to be connected to a supply circuit of rated voltage and frequency in accordance with 35.4.1, connected to maximum rated load, and operated continuously under representative service conditions that are likely to produce the highest temperature.

56.8 For power supplies using rechargeable batteries, the product is to be subject to an extended power failure (see 57.7.7) before the test is conducted. All required batteries shall be connected throughout the test.

56.9 If a current-regulating resistor or reactor is provided as a part of a unit, it is to be adjusted for the maximum resistance or reactance at intended current.

56.10 The test is to be continued until:

a) Constant temperatures are attained during the normal supervisory condition; and

b) One hour has elapsed during the normal alarm signaling condition of a unit intended to produce a continuous signal until it is restored to normal.

56.11 A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but at not less than 5-minute intervals, indicate no change.

56.12 If a product has provision for multiple zones, all initiating circuits shall be activated during the alarm condition.

57 Power Failure Test

57.1 General

57.1.1 These requirements apply to an integral or separately-provided power supply located at the protected premises and intended to supply power to the burglar alarm unit/system. Power supply requirements for receiving equipment located at the monitoring station, satellite station, or subsidiary station are specified in the Standard for Central-Station Alarm Services, UL 827. Also see Section 37, Software-Based Receiving Equipment.

57.1.2 The standby capacity for batteries provided with burglar alarm units/power supplies shall be as shown in Table 57.1.

Table 57.1
Battery Standby Time for Burglar Alarm Systems

Alarm application	Type of burglar alarm system	Standby time required	Recharge time
Mercantile Alarm[a]	Central Station, Local, Police Station	4 hours	24 hours
Mercantile Safe and Vault Alarm[a]	Central Station, Local, Police Station	4 hours	24 hours
Bank Safe and Vault Alarm[a,b]	Central Station, Local, Police Station	72 hours	72 hours
Holdup Alarm	Holdup	8 hours	48 hours
Proprietary Alarm[a]	Proprietary	24 hours[c]	48 hours
Alarm Sounding Device or Output	Central Station, Local, Police Station Proprietary	15 minutes	N/A
DACT	Any	See note d	See note d
Power Supply	Any	See note d	See note d

[a] If the product is also to provide power for an alarm sounding device, it shall provide an additional 15 minutes of standby power.

[b] Applies only to a power supply that will be located inside of the bank vault or safe.

[c] Standby capacity of less than 24 hours may be provided if a signal indicating that the protected area unit is operating on standby power is transmitted to the proprietary monitoring station before the capacity of the standby power has decreased below 4 hours. See 57.5.2.

[d] For a separately-supplied DACT or power supply, the required standby and recharge times are dictated by the requirements for the particular burglar alarm application noted in the table above.

57.1.3 Systems shall not depend solely on commercial power if failure thereof will cause a power failure or render the system inoperative.

57.1.4 Sources of electrical power that may be used for burglar alarm protected premises units include rechargeable (secondary) batteries on full float or trickle charge, a power supply with battery standby, and primary batteries.

57.1.5 If the product is equipped with terminals for the connection of standby power, the terminals shall be marked with, or reference a drawing that shows, their power ratings including voltage, current, and capacity of batteries in ampere-hours, and the number and type of batteries to be used. See 89.1(h) and (i).

57.1.6 As applicable, the Power Failure Test is to be performed in conjunction with the Temperature Test (Section 56). Also see 56.3.

57.2 Rechargeable (secondary) batteries

57.2.1 The burglar alarm unit manufacturer shall:

a) Provide all specifications, information, and calculations necessary to determine that the rechargeable battery is used within its specifications; and

b) Confirm that the charging method used complies with the battery manufacturer's specifications and continues to provide a charging current while connected to rated load, while connected to no load, and while under all conditions of intended use.

The conditions of intended use shall include over and undervoltage conditions as described under the Undervoltage Operation Test, Section 46, and the Overvoltage Operation Test, Section 47, in all combinations with the temperature variations described under the Variable Ambient Test, Section 48.

57.2.2 The charging current shall be limited so that, with the maximum rate of charge that can be obtained, the battery gases will not affect any part of the power supply. The trickle and fast charge rates of a battery shall not exceed the battery manufacturer's recommended rates.

57.2.3 A power supply using a rechargeable battery shall be tested with the battery fully charged and after an extended discharge (see 57.7.6). The battery shall continue to charge.

57.2.4 All conditions of battery discharge shall comply with the battery manufacturer's specifications, with regard to rate of discharge and with automatic voltage cutoff, if required to prevent polarity reversal or damage.

57.2.5 If two or more cells are used in series or parallel, the conditions of use shall provide for equalization of cells in compliance with the battery manufacturer's specifications.

57.2.6 The conditions of storage shall comply with the battery manufacturer's specifications with regard to position, temperature, and state-of-charge.

57.2.7 If the battery is of a type that will lose capacity as a result of long periods of inactivity, provision shall be made for cycling of the battery to prevent the condition or for a method of detecting the existence of a capacity loss.

57.2.8 A warning of precautions necessary to prevent premature battery failure, if any precautions are necessary, shall be contained in the installation instructions and shall include position of mounting, temperature limits, state-of-charge, and periods of inactivity if the battery is of a type that may lose capacity due to these conditions. Markings on the product adjacent to the battery shall indicate either battery type and estimated life, or a method of testing battery condition.

57.3 Nonrechargeable (primary) batteries

57.3.1 No. 6 size, 1-1/2-volt nonrechargeable cells may be expected to perform and require replacement at the intervals shown in Table 57.2 when used indoors on burglar alarm units, depending on whether the "ignition type" (high-amperage) or "protective alarm type" (low-amperage) cells are used.

57.3.2 Table 57.2 applies to systems wherein the load may not be applied 24 hours each day. If the battery is operated continuously, a shorter replacement period may be considered.

Table 57.2
Dry-Cell Replacement Period

Drain in milliamperes	Final working voltage	Minimum replacement period, months	
		Ignition-type cell	Protective alarm-type cell
2	1.0	12	24
3	1.0	10	22
5	1.0	7	14
6	1.0	6	12
10	1.0	4	6

57.3.3 Nonrechargeable batteries shall be replaced when the short-circuit current is less than 10 amperes or when the cell voltage is less than 1 volt while connected to a load of 1 ohm per cell. Nonrechargeable batteries shall be replaced at least annually, or every two years if of the protective-cell type, regardless of their condition.

57.3.4 A unit-type nonrechargeable battery shall be replaced when its voltage is less than two-thirds nominal voltage while connected to a load so as to deliver a current of 1 ampere.

57.4 Test method – general

57.4.1 A burglar alarm unit operated from commercial power shall be provided with standby power sufficient to operate the product for the period specified in 57.4.4 in the event of loss of the primary source of power.

57.4.2 With standby power connected, neither loss nor restoration of a commercial power source shall cause an alarm signal.

57.4.3 To determine compliance with the requirement in 57.4.2, the control unit is to be energized in the normal supervisory condition and the supply circuit is to be interrupted for 1 minute and then restored for 1 minute for a total of 10 cycles of supply circuit interruption.

57.4.4 Compliance with the requirement in 57.4.1 necessitates the automatic provision of a standby power supply in the event of commercial power loss so that the product will be maintained in the intended condition for the following periods of time:

a) Bank Safe and Vault Alarms – 72 hours.

b) Mercantile and Mercantile Safe and Vault Alarms – 4 hours.

c) Plus an additional 15 minutes of alarm load immediately following standby time period (a) or (b) (as applicable).

57.4.5 Loss of commercial power shall be indicated by the de-energization of a visual “AC power on” indicator. See 41.3.

57.4.6 Ultimate loss of battery power for the protection circuit shall result in an alarm or trouble signal.

Exception: This requirement does not apply if a signal indicating a power failure is transmitted to the monitoring station within 8 hours after the beginning of the power failure.

57.4.7 If the power supply is intended to provide a continuous output for the protection circuit and an intermittent output, such as for a code transmitter or an alarm sounding device, it shall comply with the

requirements of 57.2.1(b) while supplying the continuous output, but may provide power from the battery while supplying the intermittent output.

57.4.8 Under standby conditions, the continuous output shall not deplete the battery to a level where it cannot provide the intermittent output for the required period. This may be done by removing the constant load after the required standby time has been exceeded and before the battery capacity has fallen below that required for the intermittent load.

57.4.9 Following an extended power failure and restoration of power, rechargeable batteries shall recharge sufficiently within 24 hours to provide the required power for 4 hours of standby operation and shall recharge sufficiently within 72 hours to provide 72 hours of standby operation.

57.4.10 Compliance with the requirement of 57.4.4 is to be determined by the following procedure:

a) Fully charging the standby battery by operating the product from commercial power for not less than 7 days (168 hours); then

b) Operating the product on the standby battery for an extended power failure (see 57.4.11); then

c) Reconnecting the product to commercial power for the time period required in 57.4.9; and then

d) Operating the product on the standby batteries for the period of time required in 57.4.4.

57.4.11 An extended power failure is defined as follows:

a) 72 hours for bank vault alarms; and

b) 24 hours for mercantile and mercantile safe and vault alarms.

57.4.12 If standby power is provided from nonrechargeable batteries, provision shall be made to test the condition of the batteries.

57.5 Test method – proprietary burglar alarm

57.5.1 In addition to the requirements noted in 57.4, “Test method – general”, the requirements shown in 57.5.2 – 57.5.3 apply to proprietary burglar alarm units.

57.5.2 The capacity of the standby power shall be sufficient to operate the product for 24 hours while in the supervisory mode of operation that consumes maximum power.

Exception: Less than 24 hours standby capacity may be provided if a signal indicating that the protected area unit is operating on standby power is transmitted to the central supervising station before the capacity of the standby power has decreased below 4 hours.

57.5.3 Standby power for a protected area unit that operates a local audible alarm shall operate the audible alarm a minimum of 15 minutes at the end of the standby period specified in 57.5.2.

57.5.4 Following restoration of power after an extended power failure of 24 hours or more, the product shall recharge, within 48 hours, sufficiently to provide the required standby power.

57.5.5 If standby power is provided from primary batteries, a means shall be provided to test the condition of the battery.

57.6 Test method – holdup alarm

57.6.1 A holdup alarm unit powered by commercial power shall be provided with standby power or terminals for the connection of standby power that can operate the unit for at least 8 hours in the event of loss of the primary source of power.

57.6.2 In addition to the requirements noted in 57.4, "Test method – general", the requirements shown in 57.6.1 – 57.6.5 apply to holdup alarm units.

57.6.3 Ultimate loss of battery power during a power loss shall result in an alarm or trouble signal. The trouble signal shall have the same characteristics as an alarm signal, but shall be identifiable as a trouble signal rather than as an alarm signal. This requirement does not apply to a monitoring station power supply.

57.6.4 After an extended power loss of 24 hours and restoration of power, the product shall recharge sufficiently to provide the required standby power within 48 hours.

57.6.5 If standby power is provided from primary batteries, a means shall be provided to conveniently test the condition of the battery.

57.7 Test method – power supplies

57.7.1 In addition to the requirements noted in 57.4, "Test method – general", the requirements shown in 57.7.3 – 57.7.8 apply to power supplies.

57.7.2 The standby capacity for batteries provided with power supplies shall be as shown in Table 57.1.

57.7.3 To determine compliance with the requirements of 57.7.2, a power supply using rechargeable batteries is to be connected to a rated source of supply, see 35.4.1, with no load on the output and with the standby batteries connected and charged for 72 hours or more. The output(s) is then to be connected to a load of rated current(s) and the commercial power input disconnected. At the end of the required standby time, the output voltage(s) and current(s) shall be not less than 85 percent of the rated voltage(s) and current(s).

57.7.4 A power supply using nonrechargeable batteries shall be tested in the same manner as one with rechargeable batteries, see 57.7.3, except that the charge/recharge period is not required.

57.7.5 Following an extended commercial power failure and restoration, a power supply equipped with rechargeable batteries shall recharge sufficiently to provide the required standby power specified in Table 57.1:

a) Within 24 hours if 4 hours standby is required.

b) Within 48 hours if 8 or 24 hours standby is required.

c) Within 72 hours if 72 hours standby is required.

57.7.6 An extended power failure occurs when a power supply is connected to a rated load and the duration of lack of commercial power is:

a) 24 hours for mercantile and mercantile safe and vault alarms.

b) 48 hours for holdup and proprietary alarms.

c) 72 hours for bank safe and vault alarms.

57.7.7 The output voltage and current shall not be interrupted when the commercial input power is interrupted or restored.

57.7.8 To determine compliance with 57.7.7, the power supply is to be connected to a rated source of voltage, see 35.4.1, with fully charged batteries. The output is to be connected to a load of rated current and the input power interrupted for 1 minute and restored for 1 minute for a total of 10 cycles.

57.8 Test method – digital alarm communicator transmitters (DACT)

57.8.1 In addition to the requirements noted in 57.4, “Test method – general”, the requirements shown in 57.7.3 – 57.7.8 apply to separately-supplied DACT’s.

57.8.2 The standby capacity for batteries provided with separately-supplied DACT’s shall be as shown in Table 57.1.

57.8.3 Following an extended commercial power failure and restoration, a power supply equipped with rechargeable batteries shall recharge sufficiently to provide the required standby power specified in Table 57.1:

a) Within 24 hours if 4 hours standby is required.

b) Within 48 hours if 8 or 24 hours standby is required.

c) Within 72 hours if 72 hours standby is required.

57.8.4 An extended power failure occurs when a power supply is connected to a rated load and the duration of lack of commercial power is:

a) 24 hours for mercantile and mercantile safe and vault alarms.

b) 48 hours for holdup and proprietary alarms.

c) 72 hours for bank safe and vault alarms.

58 Abnormal Operation Test

58.1 A burglar alarm unit operating in any condition of intended operation shall not increase the risk of fire or electric shock when abnormal fault conditions are introduced.

58.2 To determine compliance with the requirement in 58.1, the product is to be connected to a source of supply in accordance with 35.4.1 and operated under the most severe circuit fault conditions likely to be encountered in service. There shall not be emission of flame or molten metal, or any other manifestation of fire; see 58.4. The product shall also comply with the requirements in the Dielectric Voltage-Withstand Test, Section 55, following the abnormal fault conditions.

58.3 The fault condition is to be maintained continuously until constant temperatures are attained or until burnout occurs, if the fault does not result in the operation of an overload protective device. Shorting of the secondary of the power supply transformer and shorting of an electrolytic capacitor represent typical fault conditions.

58.4 The product shall be wrapped in a single layer of bleached cheesecloth having an area of 14 – 15 square yards to the pound (26 – 28 m^2/kg) and having a thread count of 32 by 28, and then energized. There shall not be molten metal or flame emitted from the unit as a result of this test as evidenced by ignition or charring of the cheesecloth. The dielectric voltage-withstand test shall be conducted immediately at the conclusion of the test.

58.5 Where a product has provisions for connection to telephone, telegraph, or outside communication circuit wiring as covered by Article 800 in the National Electrical Code, ANSI/NFPA 70, the product shall comply with the requirements for protection against overvoltage from power line crosses described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, (e.g. telco overvoltage test).

59 Electrical Transient Tests

59.1 General

59.1.1 A burglar alarm unit, other than that operating from a primary battery, shall operate for its intended signaling performance after being subjected to 500 supply line transients, 500 internally induced transients, and/or 60 input/output circuit transients while energized from a source of supply in accordance with 35.4.1.

59.2 Supply line transients

59.2.1 A high-voltage AC-operated product shall not false alarm, shall operate as intended, and shall retain required stored memory (such as date, type and location of a signal transmission within the unit), when subjected to supply line transients induced directly onto the power supply circuit conductors of the product under test. Supplemental information stored within the unit need not be retained.

59.2.2 For this test, the product is to be connected to a transient generator capable of producing the Location Category A3, 100 kHz Ring Wave transient as defined in the IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits, ANSI/IEEE C62.41 (6 kV @ 200 A, 30 ohms impedance).

59.2.3 The product is to be subjected to 500 transient pulses induced at an average rate of 3 pulses every min. A total of 250 pulses are to be applied so that the transient is induced 90° into the positive phase with reference to earth ground of the 60 Hz cycle, and the remaining 250 pulses are to be induced 90° into the negative phase with reference to earth ground of the 60 Hz cycle. Of the total 250 pulses at each polarity, 225 are to be applied with the product in the normal standby condition and 25 are to be applied with the product in the alarm condition.

59.3 Internally induced transients

59.3.1 The product is to be energized in the intended standby condition while connected to a source of supply in accordance with 35.4.1. The supply source is to be alternately de-energized for approximately 1 second, then energized for approximately 9 seconds, for a total of 500 times. Each interruption is to be at a rate of not more than 6 interruptions per minute. Standby power is to be connected during this test.

59.3.2 As a result of the above test, the unit shall comply with 59.1.1, as well as the requirements in the Normal Operation Test, Section 39.

59.4 Input/output circuit transients

59.4.1 The product is to be energized in the normal standby condition while connected to a source of supply in accordance with 35.4.1. All field-wiring circuits are to be tested as specified in 59.4.2 and 59.4.3.The product and equipment connected to these circuits shall:

a) Not false alarm;

b) Operate as intended; and

c) As appropriate, retain required stored memory (such as date, type, and location of signal transmission) within the unit. Supplemental information stored within the unit need not be retained.

Exception No. 1: This test is not required when the product installation instructions indicate that it is not permitted to connect cables greater than 98.5 ft (30 m) long to the product or to specific circuits of the product under test.

Exception No. 2: Transients applied to an evaluated ITE modem or interface module of packet switched data network system, or an onboard circuit integral to the control unit, shall not affect the operation of the system except for the modem or interface circuit. Failure of the packet switched data network circuit, modem or interface module is acceptable if the loss of communication is annunciated at the monitoring station. See 40.7.4.

59.4.2 For this test, each input and output circuit is to be subjected to the transient waveforms specified in Table 59.1, as delivered into a 200-ohm load. The transient pulses are to be coupled directly onto the input/output circuit conductors of the equipment under test.

Table 59.1
Input/Output Circuit Transients

Peak voltage level, V	Minimum energy level, J	Minimum pulse duration, µs	Figure No.
2400	1.0	80	Figure 59.1
1000[a]	0.31	150	Figure 59.2
500[a]	0.10	250	Figure 59.3
100	0.011	1120	Figure 59.4

[a] Other applied transients having peak voltages representative of the entire range of 100 – 2400 volts shall be used in lieu of these values when the output circuit is only designed specifically to protect against these predetermined values. The transients shall meet or exceed the specified minimum pulse duration (Figure 59.5) and minimum energy level (Figure 59.6) parameters, and shall have an equal or faster minimum transient pulse rise time than that specified in Figure 59.7.

Figure 59.1

Input/Output Circuit Transients – 2400V Curve

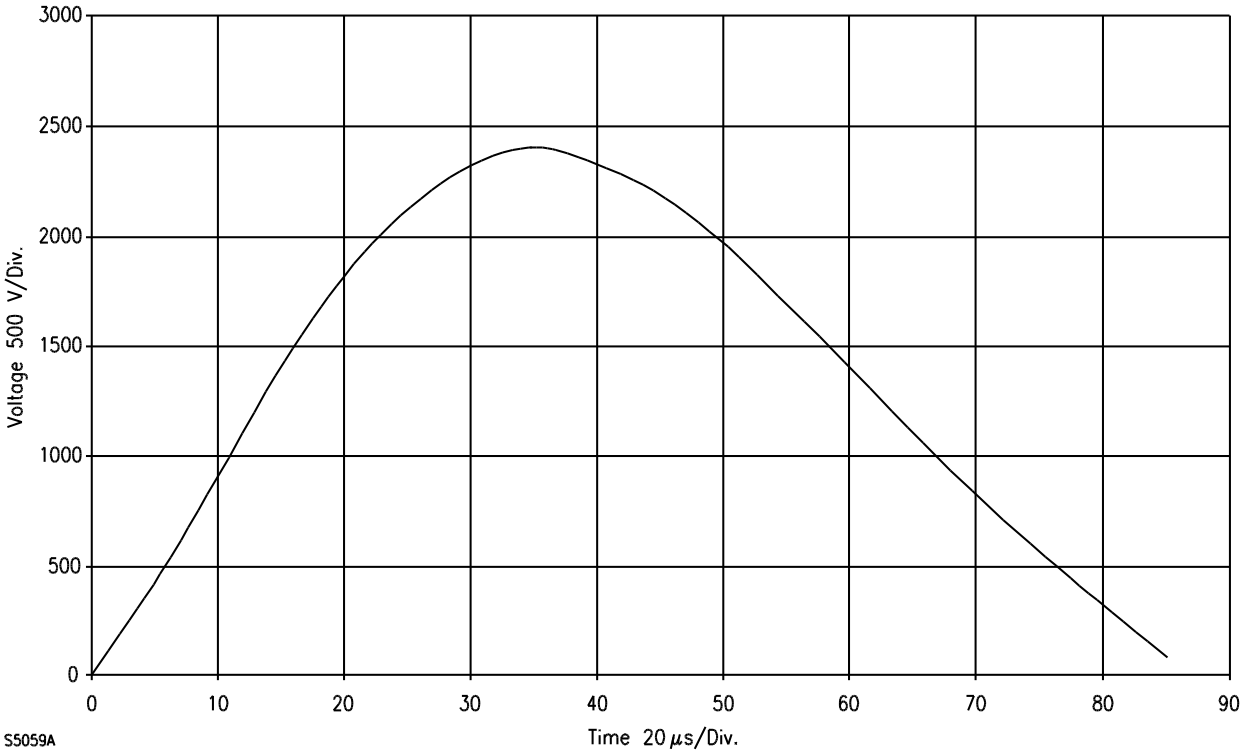


Figure 59.2

Input/Output Circuit Transients – 1000V Curve

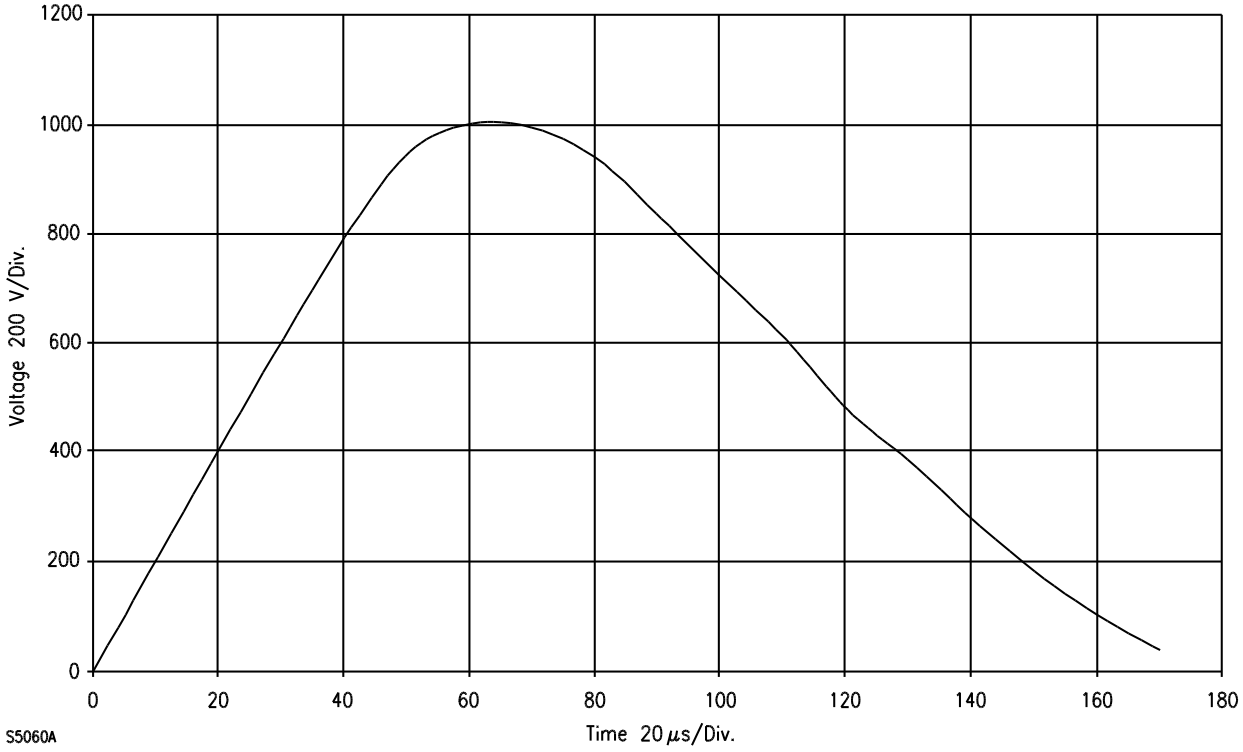


Figure 59.3

Input/Output Circuit Transients – 500V Curve

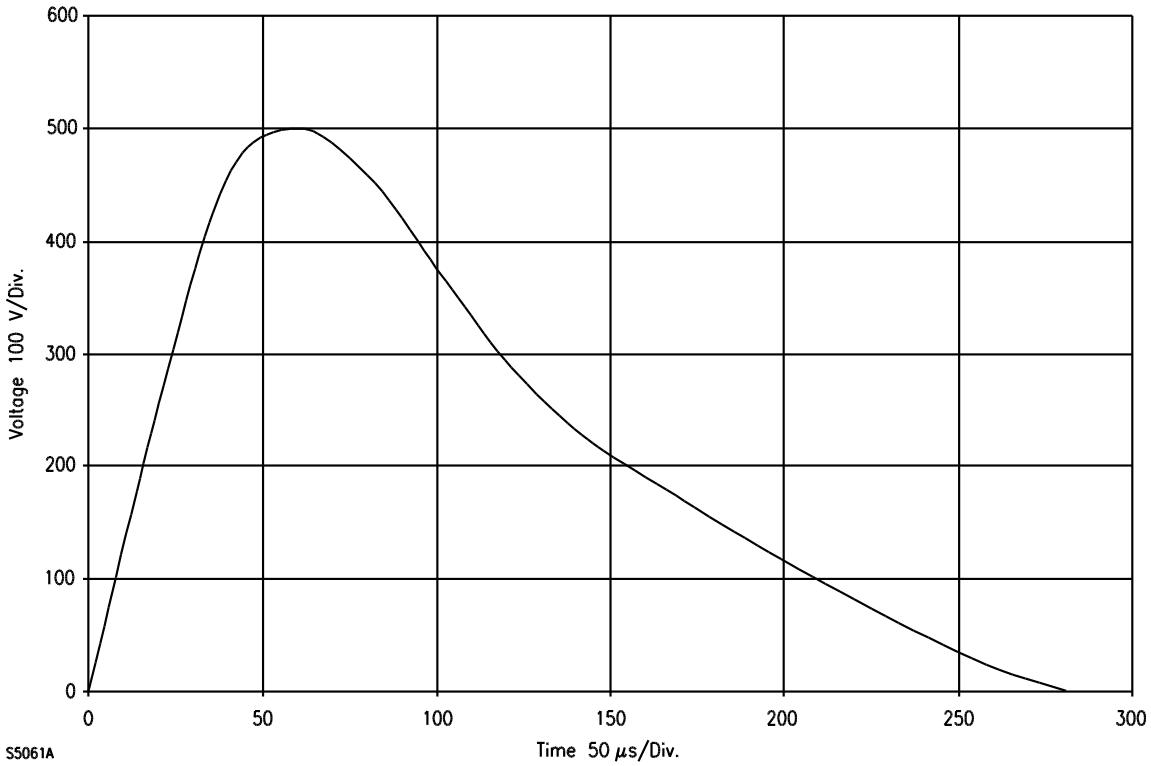


Figure 59.4

Input/Output Circuit Transients – 100V Curve

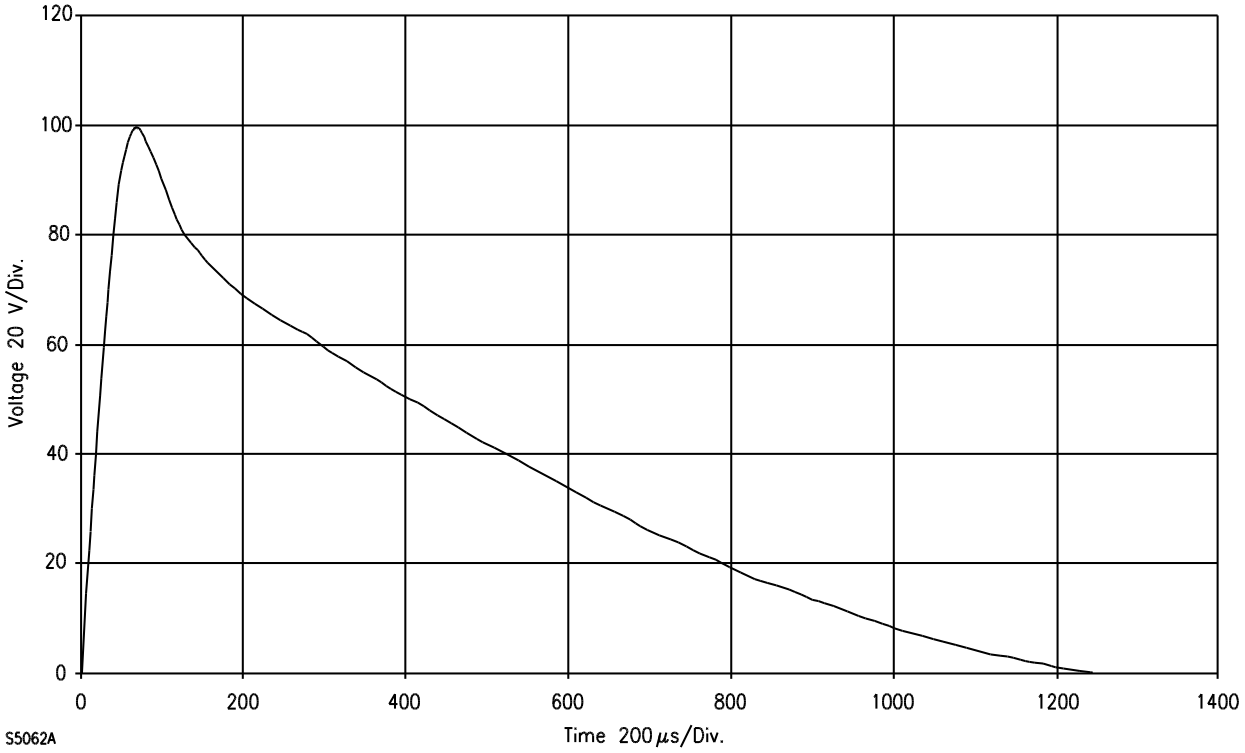


Figure 59.5

Minimum Transient Pulse Duration vs. Transient Peak Voltage

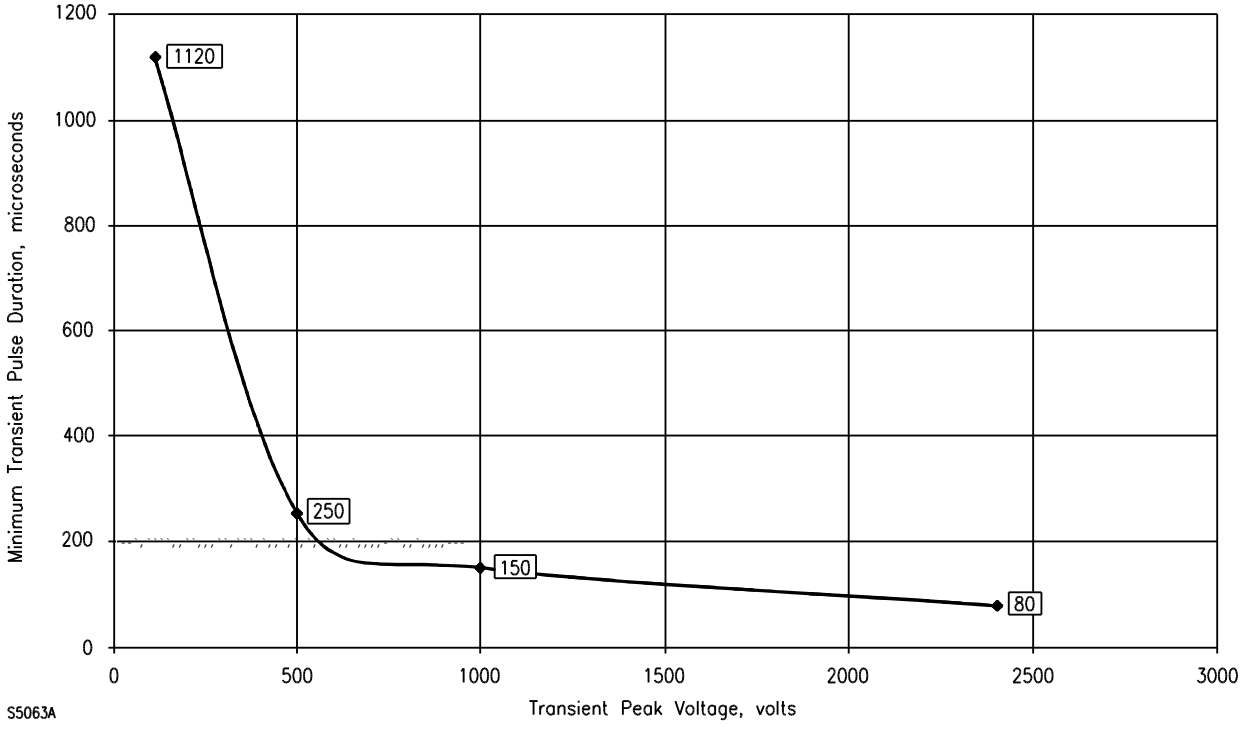


Figure 59.6

Minimum Transient Energy Level vs. Transient Peak Voltage

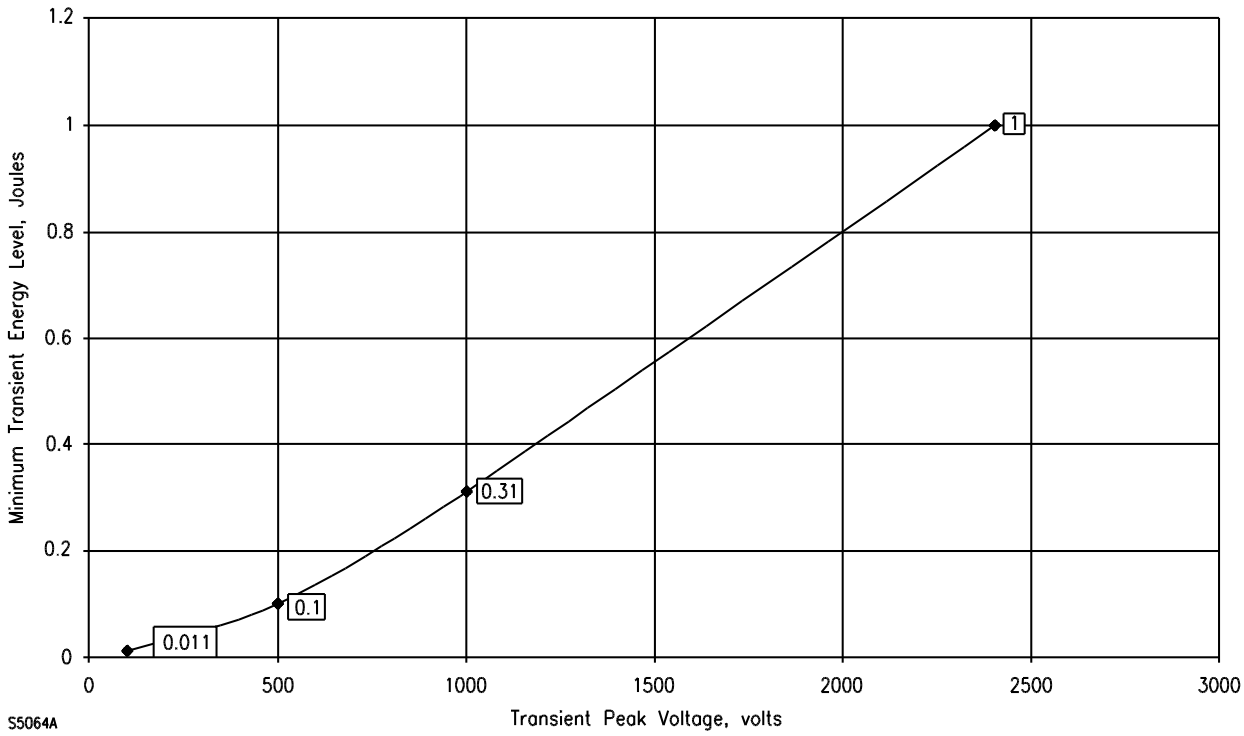
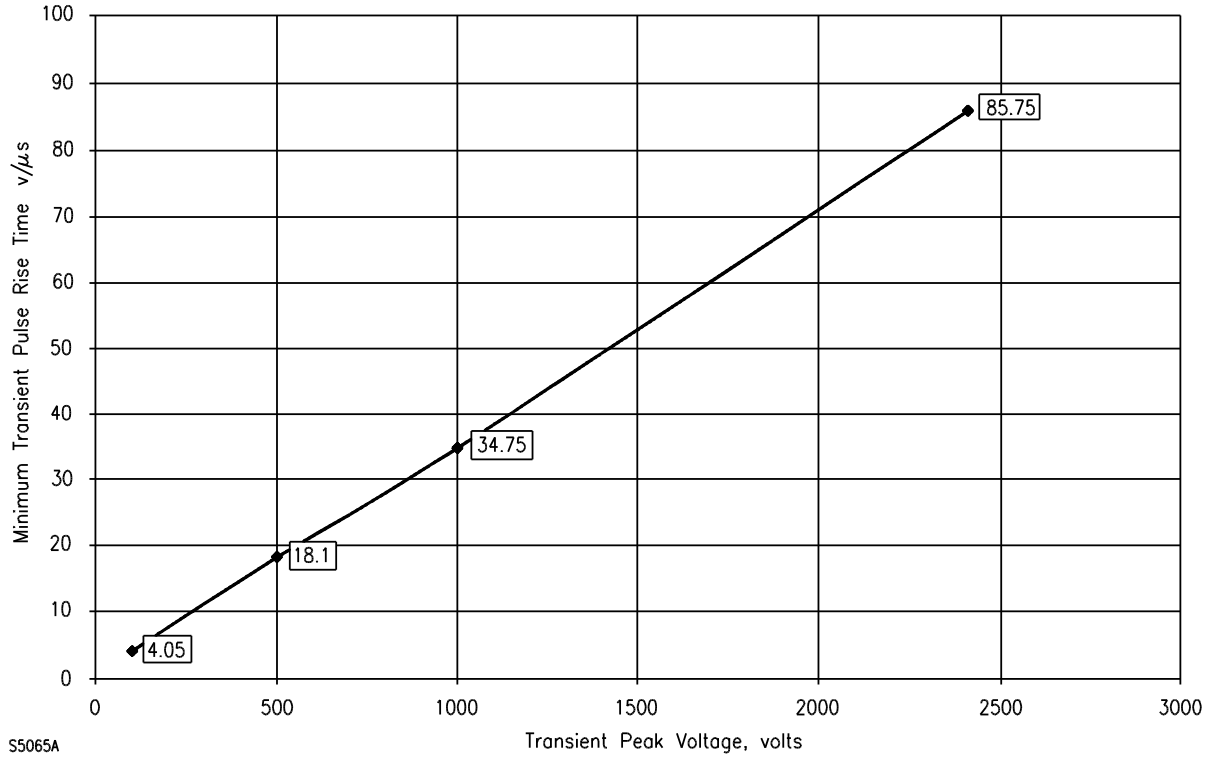


Figure 59.7

Minimum Transient Pulse Rise Time vs. Transient Peak Voltage



59.4.3 Each conductor of a circuit is to be subjected to 60 transient pulses induced at the rate of six pulses per minute as follows:

a) Twenty pulses (four at the 2400 peak voltage level and two at each of the other transient voltage levels specified in 59.4.2) between each lead or terminal and earth ground, consisting of ten pulses of one polarity, and ten of the opposite polarity (total of 40 pulses); and

b) Twenty pulses (four at the 2400 peak voltage level and two at each of the other transient voltage levels specified in 59.4.2) between each circuit pair, consisting of ten pulses of one polarity and ten pulses of the opposite polarity (total of 20 pulses).

59.4.4 As an alternate to 59.4.2 – 59.4.3, the product shall be subjected to the Standard for Surge Tests per Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test, IEC 61000-4-5: 2005, and in accordance with the following and 59.4.5 – 59.4.9.

Table 59.2
Product Test

Open Circuit Test Voltage,[a,b] Line to Ground	0.5kV and 1kV
Polarity	+ and –
Minimum number of surges at each polarity, voltage, coupling mode and signal line at a maximum rate of 1 per 5 second	5
Impedance in series with the transient generator	40 Ohm

Table 59.2 Continued on Next Page

Table 59.2 Continued

Open Circuit Test Voltage,[a,b] Line to Ground	0.5kV and 1kV
Combination Wave Generator	1.2/50 µs

[a] This test is not required when manufacturer's installation instructions indicate that it is not permitted to connect cables greater than 98.5 ft (30 m) long.

[b] The test pulses are coupled into the leads to be tested by means of appropriate coupling networks that maintain the test pulses within Standard for Surge Tests per Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test, IEC 61000-4-5 specification.

59.4.5 The product under test is to be connected in accordance with the manufacturer's installation instruction, with the intended ancillary equipment and interconnecting cables insulated from ground reference for this test. Normal operation of the product shall be confirmed prior to the test.

59.4.6 Input/output circuits shall be subjected to transients injected by line-to-ground coupling mode only, using a 40 ohm series resistor.

59.4.7 If the product has a large number of identical input/output circuits, then representative samples of each type of input/output circuit may be subjected to this test and considered representative of other identical circuits.

59.4.8 The length of the unshielded input/output circuit conductors between the product and the coupling/decoupling network(s) shall be less than or equal to 6.5 feet (2 m). If it is specified in the manufacturer's installation instructions that input/output circuits shall only be connected with shielded cables, then in these cases, the transients shall be applied directly (e.g. without the 40 ohm series resistor) to the shield of a 65.5 foot (20 m) length of shielded cable. Current compensated chokes may be used to decouple input/output circuits carrying high frequency signals, to reduce attenuation problems.

59.4.9 A minimum of 5 pulses of each polarity shall be applied at each of the 0.5 kV and 1 kV, voltage levels. The maximum pulse rate of 1 per 5 s is used. If it is necessary to ensure that any failures are not due to applying the pulses too frequently then the devices shall be replaced and the test repeated with pulses at a rate of less than 1/min.

59.4.10 As a result of the above tests, the unit shall comply with 59.1.1, as well as the requirements in the Normal Operation Test, Section 39.

60 Radio Frequency Interference (RFI) Test

60.1 A burglar alarm unit shall not false alarm and shall operate as intended when subjected to radiated radio frequency interference sources.

60.2 To determine compliance with the requirements specified in 60.1, a product is to be energized from a source of rated voltage and frequency and subjected to the radio frequency generated by sources described in 60.3.

60.3 The radio frequency interference source is to be a 5-watt radio transmitter placed 10 feet (3.05 m) from the burglar alarm unit and any connecting lead(s), radiating signals from a vertical 1/4-wave monopole antenna. All leads are to be connected according to the manufacturer's installation wiring instructions and are to be straight leads 9 feet (2.7 m) long. There are to be six trials consisting of five transmissions each, each transmission consisting of 5 seconds ON and 5 seconds OFF, with the product operating in the normal standby condition, at the following carrier frequencies:

a) 27 MHz, nominal.

b) 150 MHz, nominal.

c) 450 MHz, nominal.

d) 866 Mhz, nominal.

e) 900 MHz, nominal.

Each trial shall be from a different location with respect to the product. The antenna shall be in a vertical position.

Exception: Terminals intended solely for the connection of shielded cable are considered to comply with this requirement. This test is not required when the product installation instructions indicate that only shielded cables are to be used.

61 AC Induction Test

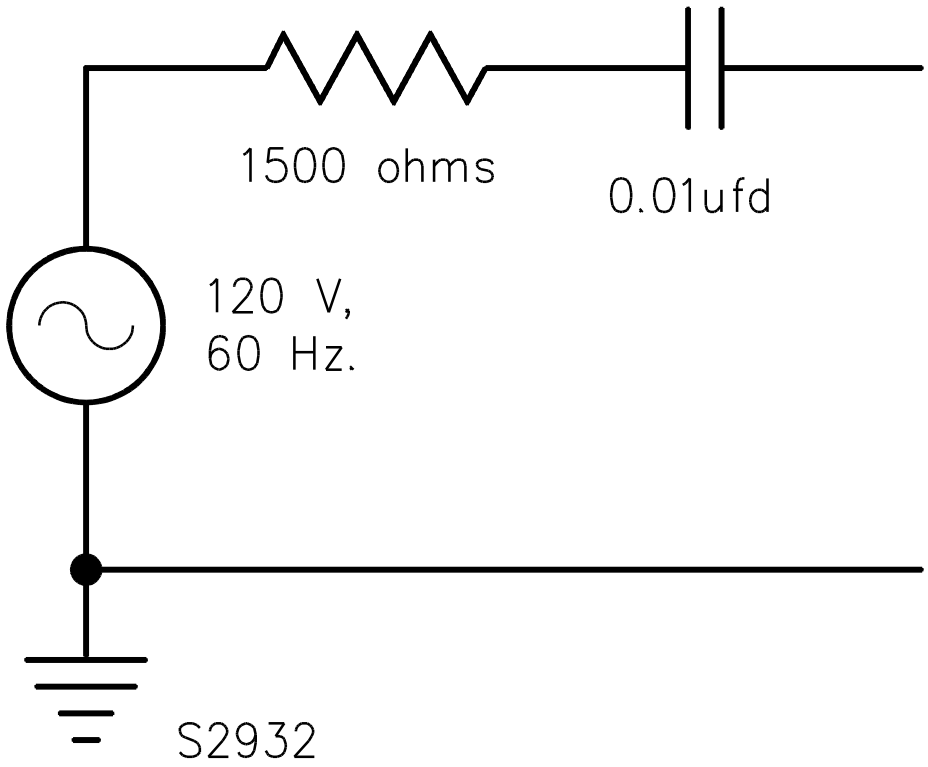
61.1 A burglar alarm unit shall not false alarm and shall operate as intended when subjected to an alternating current induced onto any field wiring terminal, field wiring lead, or any other leads which extend throughout the premises wiring.

Exception: AC power leads and any leads consisting of conductors insulated from and surrounded by a shielding conductive surface grounded at one or more ends are exempted from this requirement. This test is not required when the product installation instructions indicate that only shielded cables are to be used.

61.2 To determine compliance with the requirements in 61.1, the product is to be energized from a source of rated voltage and frequency in accordance with 35.4.1, and a 60-hertz current is to be injected into each circuit extending from the product. The AC signal current shall be induced by the circuit illustrated in Figure 61.1 to simulate induction from AC power sources.

Figure 61.1

AC Induction Test Circuit



62 Polymeric Materials Test

62.1 Polymeric materials used as an enclosure, or for the support of current-carrying parts shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

63 Battery Replacement Test

63.1 The battery connections of a burglar alarm unit shall withstand removal and replacement from the battery terminals without appreciable reduction in contact integrity. Batteries used for principal power shall be subjected to 50 cycles, and standby batteries to 10 cycles, of removal and replacement.

63.2 For this test, a product is to be installed as intended in service and the battery connections removed and replaced as recommended by the manufacturer. The product then shall comply with the requirements in the Normal Operation Test, Section 39.

64 Drop Test

64.1 A sample of a portable cord-connected high-voltage product is to be dropped four times from a height of 3 feet (0.91 m) onto a hardwood floor. If it has corners, it is to be dropped on a different corner each time, selecting the corners that appear to be most susceptible to damage. If the product has no corners, it is to be dropped on the four portions that appear to be most susceptible to damage. If the product is intended to use internally mounted batteries, the batteries are to be in place for this test.

64.2 As a result of the product being dropped onto a hardwood floor, as described in 64.1:

a) The electrical spacings within a portable cord-connected high-voltage product shall not be reduced below the limits specified in Spacings, General, Section 33, and Spacings, Components, Section 34;

b) No risk of fire after product energization as described in 64.3; and

c) No high-voltage live parts shall be exposed. See 11.3.1.2 and 11.3.1.3.

64.3 Following the test described in 64.1, the product then is to be wrapped in a single layer of bleached cheesecloth having an area 14 – 15 square yards to the pound (26 – 28 m^2/kg) and having a thread count of 32 by 28, and energized for 3 hours at rated voltage in accordance with 35.4.1. There shall be no molten metal or flame emitted from the unit, as evidenced by ignition or charring of the cheesecloth. The product shall also comply with the requirements of the Dielectric Voltage-Withstand Test, Section 55, following the test.

65 Strain Relief Test

65.1 Supply cord

65.1.1 When tested as described in 65.1.2, strain relief means provided on the flexible cord shall withstand for 1 minute without displacement, a pull of 35 pounds-force (156 N) applied to the cord. During this test the connections within the product are to be disconnected.

65.1.2 A 35-pounds-mass (15.88-kg) weight is to be secured to the cord and supported by the product so that the strain relief means will be stressed from any angle that the construction of the product permits. There shall be no movement of the cord sufficient to indicate that stress would have been transmitted to the internal connections.

65.2 Field-wiring leads

65.2.1 Each lead used for field connections shall withstand a pull of 10 pounds-force (44.5 N) for 1 minute without evidence of damage or of transmittal of stress to the internal connections.

66 Mechanical Strength Tests for Enclosures

66.1 The external enclosure of a product containing high-voltage circuits or other than power-limited circuits shall withstand a force of 25 pounds-force (111 N) for 1 minute without:

a) Permanent distortion to the extent that spacings are reduced below the values specified in Section 33;

b) Transient distortion that results in the enclosure contacting live parts; and

c) Causing openings which expose uninsulated high- or low-voltage live parts.

The force is to be applied by the curved side of a 1/2-inch (12.7-mm) diameter steel hemisphere. Any openings that occur during application of the force are to be evaluated according to the requirements specified in 11.3.1.2 and 11.3.1.3.

66.2 The external enclosure of a product containing only non-power-limited low-voltage circuits is to be subjected to the test in 66.1, except that the enclosure shall withstand an applied force of 10 pounds (44.5 N). Products containing only power-limited, low-voltage circuits are exempt from this test.

66.3 The external enclosure of a product containing high-voltage circuits or other than power-limited circuits shall withstand an impact of 5 foot-pounds (6.78 J) without:

a) Permanent distortion to the extent that spacings are reduced below the values specified in Section 33;

b) Transient distortion that results in the enclosure contacting live parts; and

c) Causing openings that expose uninsulated high-voltage live parts or non-power-limited low-voltage live parts.

The impact is to be applied by means of a solid, smooth, steel sphere 2 inches (50.8 mm) in diameter and weighing approximately 1.18 pounds (0.54 kg) falling freely from rest through a vertical distance of 51 inches (1.30 m). Any openings resulting from the impact are to be evaluated according to the requirements in 11.3.1.2 and 11.3.1.3.

66.4 The external enclosure of a product containing only non-power-limited low-voltage circuits is to be subjected to the test described in 66.3, except that the impact is to be 2 foot-pounds (2.7 J) and the sphere is to fall freely from rest through a vertical distance of 20-13/32 inches (0.52 m). Products containing only power-limited, low-voltage circuits are exempt from this test.

Exception: The Mechanical Strength Tests described in 66.1 – 66.4 are not required for metallic enclosures complying with the thickness requirements in 11.5.1, 11.6.1, and Table 11.2 – Table 11.4, however, areas of an enclosure containing perforated sheet steel or ventilation openings shall still be subjected to the tests noted above.

67 Attack Tests

67.1 General

67.1.1 A product complying with these requirements shall resist the attacks specified in the paragraphs below for the length of time required to transmit the off-premises signal(s) to the monitoring station, or to silence the local alarm sounding device.

Table 67.1
Summary of Attack Resistance Requirements

Type of system	Attack on alarm sounding device	Attack on off-premises alarm communicator
Mercantile Premises – Local	Required	N/A
Mercantile Premises – CS, PS, P	Optional	Required for code transmitters, DACT's, 1-Way radio only
Mercantile/Bank Safe & Vault – Local	Required	N/A
Mercantile/Bank Safe & Vault – CS, PS, P	Optional	Required for code transmitters, DACT's, 1-Way radio only
Code Transmitter (e.g. McCulloh)	Optional	Required
DACT	Optional	Required
1-Way Radio	Optional	Required
2-Way Radio	Optional	N/A
Multiplex	Optional	N/A
Packet Switched Data Network (PSDN)	Optional	N/A
Local = Local Burglar Alarm CS = Central Station Burglar Alarm		

Table 67.1 Continued on Next Page

Table 67.1 Continued

Type of system	Attack on alarm sounding device	Attack on off-premises alarm communicator
PS = Police Station Connected Burglar Alarm		
P = Proprietary Burglar Alarm		
N/A = Not Applicable		

67.2 Mercantile premises alarm applications

67.2.1 Off-premises alarm communicator

67.2.1.1 The enclosure protecting a system's off-premises alarm communicator in the subscriber's control unit, or as provided as a separate unit, shall resist the attacks specified in 67.2.3 long enough to permit the complete transmission of a signal to the off-premises monitoring station before the alarm communicator can be disabled. A burglar alarm power supply that provides power to an off-premises alarm communicator would also be subject to the attack requirements noted below.

67.2.1.2 The attack resistance time shall be as follows:

a) For a code transmitter system (e.g. McCulloh), the complete transmission of at least three complete code rounds. If the number of pulses in each round affects the length of time required to transmit the round, an average length of transmission shall be used to determine the attack time. A unit that can be set for 111 – 999 shall use the code 555 or 456.

b) For a digital alarm communicator transmitter complying with the requirements shown in 40.3.2, sufficient time to allow the transmitter to contact its digital alarm communicator receiver, transmit an acceptable signal, and receive a sign-off signal (kiss-off), assuming that contact is made with the receiver on the first attempt. A ten-digit number is to be used at the slowest transmission format. The transmission shall be over a local public telephone system. Ten transmissions shall be made and the average time to complete the transmission shall be the required attack resistance time.

Exception: The manufacturer may specify the slowest transmission format suitable for use in an alarm system installed in accordance with the requirements of the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681.

c) For a one-way radio system, sufficient time to allow the radio to make contact with its receiver and deliver a complete alarm signal.

d) Products employing Multiplex and/or Packet Switched Data Network technology for off-premises transmission in accordance with 40.6 and 40.7 respectively, are not subject to attack (due to the applicable 200-second communication channel supervision criteria).

67.2.1.3 Each attack is to be continued beyond the time required to complete off-premises signal transmission for an additional 60 seconds, or until the transmitter, its circuitry, or its power supply is sufficiently exposed so that if the transmitter were still operating, it could be stopped, and the additional time recorded. The minimum additional time recorded shall establish the maximum entry time delay described in 39.1.18.

67.2.1.4 If turning an alarm system off will prevent the transmission of a complete alarm to the off-premises receiving location, the switch used to turn the alarm system off shall:

a) Be key operated; or

b) Require the input of a code having at least 1000 possible codes.

Exception: This is not required for a transmission system that either immediately transmits a signal or results in an indication at the receiving location that the control at the protected premises is no longer functioning.

67.2.2 Alarm sounding device

67.2.2.1 An alarm sounding device is required for Local Burglar Alarm applications, and considered optional for Central-Station, Proprietary, and Police Station Connected Burglar Alarm applications. If the product installation instructions specify that an alarm sounding device is to be used, the attack resistance requirements noted below shall be applied.

67.2.2.2 The alarm sounding-device power supply, control switches, and circuits that can be cut or short-circuited to silence the alarm sounding-device shall be located in enclosures as specified in 11.11.

67.2.2.3 Each attack on the inside alarm housing is to be continued beyond an initial 60-second test period for an additional 60 seconds, or until the alarm has been silenced, and the additional time recorded. The minimum additional time recorded shall establish the maximum entry delay time described in 39.1.18.

67.2.2.4 The door or cover of the control unit and sounding-device power supply enclosure, or enclosures, shall be arranged so that:

a) The door or cover must be closed and secured before the user can arm the system; and

b) An alarm is initiated if the door or cover is opened while the system is armed.

67.2.2.5 The outside alarm housing shall resist, for 120 seconds, attempts to silence the alarm by the attack methods described in 67.2.3. The alarm is to be silent when the attack is started and the attack shall initiate the alarm. The outer and inner housings shall be connected in the closed protection circuit or fully insulated electric linings shall be used so that an alarm will result if the housing is penetrated by drills, pry bars, or similar tools.

67.2.2.6 If an attack against the control unit in an attempt to silence the local alarm sounding device will not prevent the complete transmission of a signal to the off-premises receiving location, the control unit is not required to offer an attack resistance. This requirement applies to a transmission system that either immediately transmits a signal or results in an indication at the receiving location that the control at the protected premises is no longer functioning.

67.2.3 Test method

67.2.3.1 The tools used in the attack tests against control units, transmitter mechanisms, power-supply enclosures, alarm housings, or the like, are to include:

a) The type of tool intended for use with the fastener used to assemble the product, excluding a key or lock pick;

b) A blade type screwdriver not more than 8 inches (203 mm) in length from the blade tip to the handle and not more than 1/4 inch (6.4 mm) square or 9/32 inch (7.1 mm) in diameter; and

c) Wire cutters, to be restricted to the cutting of conductors inside the enclosure under attack.

67.2.3.2 During the attack, the product under test is to be securely mounted in its intended position on a 3/4 inch (19 mm) thick plywood board extending a minimum of 12 inches (305 mm) beyond each edge of the product which is, in turn, mounted on a substantial rack. The attack is to be performed by one operator.

67.2.3.3 The product is to be subjected to three separate attacks as follows:

a) An attempted disassembly using the tool designed for use on its fasteners;

b) A forcing attack using the blade-type screwdriver; and

c) A combination of disassembly and forcing attack.

67.2.3.4 The forcing attack is to be mounted against the enclosure cover, against any slot 1/8 inch (3.2 mm) or more wide, against any other unobstructed opening having a minimum dimension of 1/8 inch or more, and against any knockout not on the mounting surface.

67.2.3.5 Knockouts are to be subject to a forcing attack using the screwdriver described in 67.2.3.1(b).

67.2.3.6 If more than one opening provided for the passage of conductors through the product enclosure exceeds 3/8 inch (9.5 mm) in any dimension, each of these openings shall be subjected to attack using the screwdriver described in 67.2.3.1(b). If only one such opening is provided, it is not to be subject to attack.

67.3 Bank safe and vault alarm applications

67.3.1 Off-premises alarm communicator

67.3.1.1 See 67.2.1 for the attack resistance requirements for off-premises alarm communicators.

67.3.2 Alarm sounding device

67.3.2.1 An alarm sounding device is required for Local Burglar Alarm applications, and considered optional for Central-Station, Proprietary, and Police Station Connected Burglar Alarm applications. If the product installation instructions specify that an alarm sounding device is to be used, the attack resistance requirements noted below shall be applied.

67.3.2.2 The alarm housing shall resist for a period of 5 minutes all attempts to silence the alarm by use of the tools specified in 67.3.3.1.

67.3.2.3 In addition to the requirements of 67.3.2.2, mechanical safeguards shall be placed around the ringing mechanism, sources of energy, and the like, to withstand for 15 minutes any attempt to defeat the alarm mechanism, by use of the tools specified in 67.3.3.1 and 67.3.3.2, before it has had an opportunity to initiate an alarm.

67.3.2.4 The cable connecting the safe or vault with the alarm housing shall employ balanced electrical circuits arranged to resist an attack on the cable by an expert having detailed knowledge of the circuit employed and equipped with the measuring instruments and tools specified in 67.3.3.5.

67.3.2.5 The provision for turning off the alarm from the control unit shall be guarded by a key lock or combination, except in systems where this control is inoperative during the closed periods.

67.3.3 Test method

67.3.3.1 The tools used in the attack tests of 67.3.2.2 are to include hammers, chisels, adjustable wrenches, pry bars, punches, and screwdrivers. The hammers are not to exceed 3 pounds-mass (1.36 kg) in head weight, and no tool is to exceed 18 inches (45.7 mm) in length.

67.3.3.2 The tools used in the attack tests of 67.3.2.3 are to include those described in 67.3.3.1 and in addition, are to include drills, fish wires, firearms, hooks, and lines.

67.3.3.3 Drill bits are not to exceed 1/4 inch (6.4 mm) in diameter, are to be high-speed bits, and are to be used in a 1/4 inch capacity electric drill rated not greater than 2000 revolutions per minute.

67.3.3.4 The firearm used shall be a .38 special revolver with an 8-1/4 inch (210 mm) barrel, and shall be used to fire a 158 grain (10.2 g) lead .38 special bullet from a distance of 12 – 15 feet (3.7 – 4.6 m).

67.3.3.5 The measuring instruments and tools used in the attack test described in 67.3.2.4 shall include not more than four multimeters, jumper wires with clips or needle point probes, wire cutters, wire strippers, needle point pliers, and knives.

67.3.3.6 Multimeters shall be capable of measuring volts, amperes, and resistance, and on the voltage ranges shall have an input impedance of 10,000 ohms/volts or higher.

67.3.3.7 The product under test is to be securely mounted in its intended position on a 3/4 inch (19.1 mm) thick plywood board that extends not less than 12 inches (305 mm) beyond each edge of the product and then to a substantial rack. The attack shall be carried out by a single operator.

68 Special Terminal Assemblies Tests

68.1 General

68.1.1 To determine compliance with the requirements in 17.3.1 and 17.3.2, representative samples of the terminal assembly shall comply with the requirements in 68.2.1 – 68.5.2.

Exception: Terminals complying with the requirements in any of the standards specified in 17.2.1 are not required to be subjected to these tests.

68.2 Disconnection and reconnection

68.2.1 If a wire is to be disconnected for testing or routine servicing and then reconnected, each terminal shall be subjected to twenty alternate disconnections and reconnections prior to the tests described in 68.2.2 – 68.5.2.

68.2.2 A terminal connection shall withstand, without separating from the wire, the application of a pull of 5 pounds-force (22.2 N), applied for 1 minute to the wire in the direction which would most likely result in pullout.

68.2.3 Six terminal assemblies using the maximum wire size and six assemblies using the minimum wire size are to be subjected to this test. If a special tool is required to assemble the connection it is to be used, in accordance with the manufacturer's instructions. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 5 pounds-force (22.2 N) is reached.

68.3 Flexing test

68.3.1 The wire attached to a terminal shall withstand five right angle bends without breaking.

68.3.2 Six terminal assemblies using the maximum wire size and six using the minimum wire size shall be subjected to this test. The wires are to be assembled to the terminals using any special tool required, according to manufacturer's instructions. The terminal is to be rigidly secured to prevent any movement. With each wire in 3 pounds-force (13.3 N) tension and held at a point 3 inches (76.2 mm) from the terminal-to-wire junction, each wire is to be bent at a right angle from its nominal position.

68.4 Millivolt drop test

68.4.1 The millivolt drop across a terminal connection using the maximum and minimum wire sizes intended to be used shall not be greater than 300 millivolts with the maximum current specified by the manufacturer flowing through the terminal connections and the circuit connected to rated voltage.

68.4.2 Six terminal assemblies using the maximum wire size and six assemblies using the minimum size shall be subjected to this test. The wires are to be assembled to the terminals, using any special tool, if required, according to the manufacturer's instructions. The millivolt drop is to be measured by using a high impedance millivoltmeter.

68.5 Temperature test

68.5.1 The maximum temperature rise on a terminal junction using the maximum and minimum wire sizes with which the terminal is intended to be used shall not be greater than 30 °C (86 °F) based on an ambient temperature of 25 °C (77 °F).

68.5.2 Six terminal assemblies using the maximum wire size and six using the minimum size shall be subjected to this test. The wire is to be assembled to the terminals using any special tools, if required, according to the manufacturer's instructions. The maximum current to which the wire will be subjected in service then is to be passed through the series connection of the terminals. The maximum temperature rise is to be measured by the thermocouple method after temperatures have stabilized.

69 Short Range Radio Frequency (RF) Tests

69.1 General

69.1.1 These requirements cover the operation of control units and systems that utilize initiating, annunciating, and remote control devices that are not interconnected by a solid medium, such as cable, optical fiber, or the like, but provide signaling by means of low power radio frequency (RF) in accordance with the Code of Federal Regulations (CFR), Title 47, Part 15. Such control units and systems shall comply with Sections 1 – 68 in this standard except that in the event of conflict, the requirements in this section shall apply.

69.1.2 These requirements are applicable:

a) To a system configuration consisting of multiple transmitters and a single receiver with the transmitters operating on a random basis; and

b) To a system using such configurations as multiple receivers or a two-way interrogate response signaling system.

69.1.3 Initiating circuit transmitters that are powered by a nonrechargeable (primary) battery shall serve only one device and shall be individually identified at the receiver/control unit.

Exception: More than one device may be served by one transmitter if the transmitter and the devices are located in the same room, and the devices all service the same function, such as:

a) Door contacts;

b) Window contacts;

c) Motion detectors; or

d) Glass break detectors.

69.1.4 The transmitter/receiver shall comply with the following:

a) The communication between each transmitter and receiver shall uniquely identify each signal status.

b) The communication shall include means for uniquely identifying each transmitter.

c) The communication message components that identify the individual transmitter shall permit at least 256 unique combinations. For larger systems, the number of combinations shall be increased so that the number of combinations available to the system is numerically equivalent to eight times the maximum number of transmitters that may be used within the system. For example, if 50 transmitters are used, the system's capability shall provide at least 400 unique combinations.

69.1.5 A transmitter that is powered from a nonrechargeable (primary) battery may shut down for a maximum period of 3 minutes after a transmission sequence in order to conserve its battery if it is used with a motion detector, a public door, or other application where it could be frequently triggered during the disarmed period of the alarm system. After the 3-minute shut down, the transmitter shall initiate a transmission sequence the next time the device that it is connected to is operated.

69.1.6 A repeater is a transceiver (transmitter/receiver) that is used to receive transmissions from transmitters and relay the signals to the receiver/control unit. A repeater shall comply with all of the requirements that apply to a transmitter.

69.2 Reference level determination

69.2.1 The installation document for the system shall include information concerning the following:

a) Minimum signal strength level needed at the receiver to comply with the requirements of this section;

b) Maximum ambient radio-frequency noise level or minimum signal-to-noise level which can exist and still meet the requirements of this section;

c) A description of the equipment and procedures to be used during the installation of the system to determine whether or not the actual signal strength received is above the minimum acceptable level and the actual ambient noise level is below the maximum acceptable level.

69.2.2 For the purpose of these requirements, the minimum signal strength required, as declared by the manufacturer for normal operating performance, is designated as the reference signal level. The ambient radio-frequency noise level that would not affect normal operating performance is designated as the maximum ambient noise level, see 69.13.1.

69.2.3 Unless indicated otherwise, the test setup is to employ a transmitter that is to be connected directly to the receiver via a shielded electrical connection, and all measurements shall be taken in a RF-shielded room. The signal shall be attenuated such that the level measured at the receiver (using the method described in 69.2.1) equals the reference signal level or minimum signal to noise level.

Exception: When the transmitter is not capable of being connected via a shielded electrical connection, the transmission path is to be free field in a RF-shielded room.

69.2.4 For test purposes, products employing spread spectrum technologies shall provide a means to establish the reference signal level by preventing frequency hopping.

69.3 Interference immunity test

69.3.1 A receiver/transmitter combination at the minimum declared reference signal level shall operate for its intended signaling performance in the noise environment described in 69.3.3.

Exception: The noise environment is not applicable to products utilizing spread spectrum technology.

69.3.2 Operation of the receiver/transmitter combination shall comply with the requirements in 69.7 and 69.8, while in the noise environment.

69.3.3 For the purpose of this requirement, the noise environment is one in which the interference signal level is equal to the maximum ambient noise level as measured at the receiver in accordance with 69.2. This condition is intended to test the receiver's ability to discriminate the desired message from background noise under worse-case conditions.

69.3.4 The noise environment is to be created by a white-noise generator modulating an RF signal generator in which the frequency is twice the bandwidth about the signaling frequency. The signal strength and ambient noise levels are to be in accordance with the manufacturer's specified levels (see 69.2.1). The interference is to either emanate from a tuned 1/2 wave dipole antenna, capable of 360° rotation in order to vary the polarization, or be injected into the product via a shielded electrical connection.

69.4 Frequency selectivity test

69.4.1 If a product utilizes multiple frequencies, a receiver shall not respond to any signal having:

a) A signal strength determined to be equivalent to the most powerful system transmitter; and

b) A frequency shifted more than two working channel widths of the system, as measured between the manufacturer's rated upper and lower frequency limits of the receiver/transmitter combination.

For example, if the communication channel is 5 MHz wide, any signal with a similar band width, even one with identical coding, the center frequency of which is shifted by more than 10 MHz, shall be ignored by the receiver.

Exception: The requirements in 69.4 are not applicable to products employing spread spectrum technology.

69.4.2 A receiver is to be connected to a source of rated supply and is to be positioned for intended use.

69.4.3 A sample transmitter that is adjusted for receiver-acceptable information is to be tuned to a center frequency that is shifted from the receiver's tuned center frequency by twice the band width of the transmitter/receiver combination. The transmitter is then to be repeatedly activated as specified in 69.4.1, and the receiver shall not provide an output to any signal transmitted.

69.4.4 This test is to be conducted for frequencies above and below the receiver frequency, including a minimum of at least ten additional frequencies randomly selected about the center frequency (0.5 MHz – 1.024 GHz) and outside the frequency as specified in 69.4.1.

69.4.5 The test is to be monitored by a spectrum analyzer or other instrument that has been determined to be equivalent to verify transmitter output.

69.4.6 For test purposes, if the operating frequency or signal level, or the like, of a transmitter cannot be varied, the transmitter may be partially replaced by an RF signal generator or the entire transmitter assembly may be replaced by a combination of a programmable processor and an RF signal generator.

The processor is to produce the base band signal which modulates the RF signal generator output, if similar signal levels are generated at the receiver.

69.5 Clash test

69.5.1 For the purpose of these requirements, clash is a loss of messages at the receiver for a period greater than 90 seconds as a result of two or more transmitters being concurrently activated when only one is in an alarm mode so that their transmitted signals interfere with each other.

Exception: The requirements in 69.5 are not applicable to products employing frequency hopping, spread spectrum technology.

69.5.2 The manufacturer shall provide a derivation of the probability of successful signal transmission, based on the probability of clashes occurring. This derivation shall provide explicit operating parameters and shall describe all the assumptions and equations used in the derivation.

69.5.3 The clash rate relative to normal status transmissions for each specific signal shall not exceed the following values:

a) 0.0001, for fire signals;

b) 0.0002, for medical, duress, holdup, or panic signals;

c) 0.0005, for security signals;

d) 0.005, for other signals, not including supervision.

69.5.4 The calculated clash rate for any given system is a function of the:

a) Maximum number of transmitters (transmitters for neighboring systems are not to be considered);

b) Duration of individual transmission;

c) Transmission rate;

d) Coding scheme;

e) Error (falsing) rate; and

f) Prioritization.

When determining this rate for each type of signal noted in 69.5.3, each specified factor is to be considered in the evaluation.

69.5.5 If an alarm signal and another signal, alarm or otherwise, are transmitted at precisely the same time, the signal received at the receiver shall be correct for one of the two, for both, or shall not be accepted by the receiver as a correct signal.

69.6 Clash error test

69.6.1 A receiver shall demonstrate a zero clash error rate while subjected to the test conditions described in 69.6.3 – 69.6.5.

Exception: The requirements in 69.6 are not applicable to products employing spread spectrum technology.

69.6.2 For the purpose of these requirements, clash error is defined as the misinterpretation by the receiver of two simultaneous or overlapping valid transmitter signals that result in the receiver locking-in and annunciating a third (false) signal.

69.6.3 The receiver is to be mounted in a position of intended use and energized from a source of rated supply. Two transmitters, energized from a rated source of a supply or from a DC power supply in place of their nonrechargeable (primary) batteries, are to be adjusted such that the reference level signal described in 69.2.2 is present at the receiver. The address of each transmitter is to be set such that the logical "or" of the two addresses is a valid address recognized by the receiver.

69.6.4 One transmitter is to then be conditioned for continuous alarm transmission. The other transmitter shall be conditioned to transmit an alarm message at a rate equal to twice the alarm message length for a total of 100,000 transmissions.

69.6.5 The test described in 69.6.3 and 69.6.4 is to be repeated while one transmitter is conditioned for continuous alarm transmission and the other transmitter is conditioned to transmit a normal supervisory status message at a rate equal to twice the normal supervisory message length for a total of 100,000 transmissions.

69.7 Error (falsing) rate test

69.7.1 For the purpose of these requirements, the error (falsing) rate is a measure of the ability of a receiver to discriminate between correct and incorrect transmission so that false or erroneous messages are not accepted by the receiver as valid status indications from the various transmitters in the system.

69.7.2 As a measure of compliance with 69.7.1, the error (falsing) rate of the receiver is to be determined by utilizing the following test procedure:

a) Batteries depleted to the trouble signal level are to be installed in the transmitter. A depleted battery may be replaced by a circuit arrangement that does not affect the RF characteristic, and does simulate the characteristics of a depleted battery.

b) The transmitter is to be adjusted so that the receiver receives the reference level signal indicated in 69.2.2.

c) A counter is to be connected to the transmitter to record the number of messages. The arrangement is not to interfere with the transmitter output.

d) The transmitter is to be conditioned for continuous transmissions:

1) 1,000,000 messages with one element incorrect; then

2) 1,000,000 messages with two elements incorrect; and finally

3) 100,000 messages with three elements incorrect.

e) A counter is to be connected to the receiver that will record the number of incorrect messages accepted as valid messages by the receiver.

f) The transmitter/receiver combination shall comply with Table 69.1. Testing shall be completed at each of the three conditions of incorrect transmission in the order indicated.

g) When zero incorrect messages having one or two incorrect elements are accepted as valid after the first 100,000, the testing at that number of incorrect elements per message shall be terminated and testing at any higher number of incorrect elements per message is not required to be conducted.

Table 69.1
Error (Falsing) Rate

Number of incorrect elements per message	Messages completed	Maximum number of incorrect messages accepted as valid
1	1,000,000	2
2	1,000,000	1
3	100,000	0

69.7.3 The test is to be conducted in the noise environment described in 69.3.1 – 69.3.4.

Exception: The noise environment is not applicable to products utilizing frequency hopping, spread spectrum technology.

69.8 Throughput rate test

69.8.1 For the purpose of these requirements, the throughput rate is a measure of the ability of a receiver to accurately interpret and execute upon receipt of a correct message in order to achieve a high degree of assurance that alarm or emergency messages are not lost. The transmitter/receiver combination shall be structured so that alarm or emergency messages take precedence over all other signals. The prioritization may be achieved by extending the duration of the message, repeating the alarm or emergency message, or any other means that can be demonstrated to be equivalent. If multiple services are utilized on the same system, the priority levels of signals shall be:

a) Fire alarm;

b) Medical, duress, holdup, or panic alarm;

c) Burglar alarm;

d) Trouble or supervisory messages;

e) All other messages.

69.8.2 The throughput rate of the receiver is to be determined by utilizing the test procedure described for the error (falsing) rate, 69.7.1 – 69.7.2, except that only correct messages of each type are to be transmitted. The test results shall comply with Table 69.2. The test may be terminated after 100,000 cycles rather than 1,000,000 if the test results comply with the 100,000 messages completed row in Table 69.2.

Table 69.2
Throughput Rate

Type of message	Messages completed	Maximum number of missed messages in test conditions
Fire	100,000	4
	1,000,000	50
Medical, duress, holdup, or panic	100,000	9
	1,000,000	100
Burglar	100,000	19
	1,000,000	200

Table 69.2 Continued on Next Page

Table 69.2 Continued

Type of message	Messages completed	Maximum number of missed messages in test conditions
Trouble or supervisory	100,000	19
	1,000,000	200
Other	100,000	38
	1,000,000	400

69.8.3 The test is to be conducted in the noise environment described in 69.3.1 – 69.3.4.

Exception: The noise environment is not applicable to products utilizing spread spectrum technology.

69.9 Time to report alarm test

69.9.1 The transmitter/receiver combination shall be arranged so that the occurrence of an alarm or emergency condition at any transmitter will be immediately communicated to the receiver/control unit and from there to the monitoring station. Under unusual or abnormal operating conditions (such as clash or interference), this signal may be delayed for a period not exceeding 90 seconds.

69.9.2 A signal from an RF initiating device shall latch at the receiver/control unit until manually reset and shall identify the particular RF initiating device in alarm.

Exception No. 1: If the identification of the RF initiating device is transmitted to the central-station, the signal is not required to latch.

Exception No. 2: Check-in signals required by Inoperative Transmitter Reporting, 69.10, are not required to latch and identify.

69.9.3 To provide higher priority to alarm and emergency signals than to other signals, such signals shall be either continuous or periodically repeated at intervals not exceeding 60 seconds until the initiating device is returned to its normal condition. If the signal is continuous, the transmitter shall be limited to a maximum 15 percent duty cycle measured over a 1-minute interval.

Exception: Transmitter/transceiver/receiver combinations utilizing two-way communication where all the following conditions are met does not need to comply with 69.9.3:

a) The transceiver/receiver acknowledges receipt of the change of status signal to the corresponding transceiver/transmitter; and

b) The receiver/control unit annunciates the current trouble status of the corresponding input or output RF device after manual reset of the receiver/control unit.

69.10 Inoperative transmitter reporting test

69.10.1 A receiver/control unit shall report an inoperative transmitter in the system to the monitoring station within 4 hours after the transmitter becomes inoperative. The report shall indicate that there is an inoperative transmitter and shall identify the transmitter or the identity of the transmitter shall be latched-in at the receiver/control unit.

69.10.2 The normal periodic transmission from a wireless initiating device shall, by transmitting at a reduced power level of at least 3 decibels or by other means, provide additional assurance of successful alarm transmission capability.

69.10.3 The requirements in 69.10.2 are met through compliance with the requirements for Clash, 69.5; Error (Falsing) Rate, 69.7; Throughput Rate, 69.8; and the Transmitter Accelerated Aging Test, 69.15.

69.11 Battery status indication test

69.11.1 A transmitter shall supervise the capacity of the battery. The battery shall be monitored while loaded by transmission of the transmitter, or a load determined to be equivalent to the load imposed by transmission.

69.11.2 A trouble status signal shall be transmitted to the receiver before the battery capacity of the transmitter has depleted to a level insufficient to power the unit for a minimum of 7 days. The trouble signal shall be retransmitted at intervals not exceeding 4 hours until the battery is replaced or is depleted.

69.11.3 The battery (of the transmitter) shall be capable of operating the transmitter, including the initiating device (if powered by the same battery), for not less than 1 year of normal signaling service before the battery depletion threshold specified in 69.11.2 is reached.

69.11.4 Annunciation of low battery trouble at the receiver/control unit shall be distinctly different from alarm, supervisory, tamper, and initiating device trouble signals. It shall consist of an audible and visual signal which shall identify the affected transmitter.

69.11.5 The battery trouble status signal may be transmitted at the normal supervisory status report time of the transmitter. The audible annunciation of a battery trouble signal at the receiver/control unit may be delayed for a maximum period of 4 hours.

69.11.6 The audible signal of the receiver may be silenceable if provided with an automatic feature to reinstate the signal at intervals not exceeding 4 hours.

69.11.7 The trouble status signal shall persist at the receiver/control unit until the depleted battery has been replaced.

69.11.8 Any mode of failure of a nonrechargeable (primary) battery in an initiating device transmitter shall not affect any other initiating device transmitter.

69.12 Tamper protection test

69.12.1 Removal of a transmitter from its installed location or the removal of a cover exposing its battery shall cause immediate transmission of a trouble signal to the receiver/control unit that will, in turn, result in a signal individually identifying the affected device being transmitted to the monitoring station. When the system is in the armed condition, the signal to the monitoring station shall be an alarm signal. When the system is in the disarmed condition, the signal to the monitoring station may be a trouble signal.

Exception: If the affected transmitter is identified with a latched-in display at the receiver/control unit, the signal to the monitoring station need not identify the transmitter.

69.13 Interference protection test

69.13.1 Reception of any unwanted (interfering) transmission by a retransmission device (repeater), or by the receiver/control unit that exceeds the maximum specified ambient noise level or minimum signal-to-noise ratio (see 69.2.1, 69.2.2) for a continuous period of 20 seconds or more, that would inhibit any status change signaling within the system, shall result in a local audible trouble signal indication at the receiver/control unit, or a trouble signal being transmitted to the monitoring station. This indication shall

identify the specific trouble condition (interfering signal), as well as the device(s) affected (repeater and/or receiver/control unit).

Exception: If the condition is identified with a latched-in display at the receiver/control unit, the signal to the monitoring station may be a general trouble signal.

69.14 Transmitter stability test

69.14.1 While subjected to the environmental conditions indicated below, the transmitter/receiver combination shall complete 500 alarm transmissions as specified in 69.8.1 and 69.8.2, without a message being missed.

a) 0 ±2 °C (32 ±3 °F) for 3 hours;

b) 49 ±2 °C (120 ±3 °F) for 3 hours;

c) 85 ±5 percent relative humidity at 30 ±2 °C (86 ±2 °F) for 24 hours.

69.15 Transmitter accelerated aging test

69.15.1 The transmitter/receiver combination shall complete 500 alarm transmissions as described in 69.8.1 and 69.8.2, without a message being missed, after the transmitter has been exposed for 30 days to an ambient temperature of 70 ±2 °C (158 ±3 °F), followed by a stabilization period of 24 hr in an ambient temperature of 23 ±2 °C (73 ±3 °F).

69.15.2 During the test, the unit is to be powered from either a separate power supply adjusted to the rated nominal battery voltage, or the battery if it is capable of maintaining nominal voltage for the test duration.

69.16 Operability test – holdup alarm

69.16.1 A radio frequency-operated holdup alarm initiating device shall provide a method of testing the operating ability of each device to initiate a holdup alarm. The performance of the test shall not cause a holdup alarm to be transmitted to the monitoring station. The test method shall be documented in the product installation instructions.

69.17 Drop test – holdup alarm

69.17.1 A sample of a radio frequency-operated holdup alarm initiating device is to be dropped four times from a height of 3 feet (0.9 m) onto a hardwood floor. If it has corners, it is to be dropped on a different corner each time, the four corners that appear to be most susceptible to damage being selected. If the device has no corners, it is to be dropped on a different part each time, the four portions that appear to be most susceptible being selected.

69.17.2 The device is to be inspected following the test to determine that electrical spacings have not been reduced below the limits specified in Spacings, General, Section 33.

69.17.3 The device shall be operative and its range shall not decrease more than 25 percent from that determined in the Reference Level Determination, 69.2, following the completion of this test.

69.18 Installation instructions and user manual

69.18.1 The installation instructions and user manual shall include at least the following:

a) Specific and detailed installation limitations for RF equipment, such as building construction, possible effect of metallic bodies that may not be visible, specification of procedures, installation aids, and test equipment (by manufacturer and model number or the equivalent) needed to install the system as intended, and specific receiver-to-transmitter orientations;

b) The maximum separation (range) of the equipment, including indication that the manufacturer's specified range is for comparative purposes only and may be significantly reduced when the equipment is installed in a typical installation;

c) Instructions to test the system for operation upon completion of installation; and

d) Instructions to replace transmitter batteries yearly.

70 Long-Range Radio Frequency (RF) Devices

70.1 The requirements that cover the operation and performance of products and systems that utilize long-range radio frequency (RF) transmission paths, both one-way and two-way, between a transmitter unit and a receiver are found in the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

OUTDOOR USE EQUIPMENT

ASSEMBLY

71 General

71.1 A product or section of a product intended for installation where it may be exposed to the effects of weather shall comply with the requirements of the preceding sections of this standard and shall, in addition, comply with the following requirements.

72 Construction

72.1 General

72.1.1 An enclosure or enclosures exposed to weather shall be constructed to prevent the wetting of live parts as specified in the requirements of this section.

72.1.2 To determine compliance with 72.1.1, a complete assembly, with supply conduit connections but without pipe thread compounds, is to be subjected to the Rain Test, Section 76.

72.1.3 Enclosures for electrical components shall have provision for drainage if knockouts or unthreaded openings in the enclosure are used.

72.1.4 Except as specified in 72.1.5, cabinets and enclosures shall have a thickness of not less than:

a) 0.032 inch (0.81 mm) if of uncoated sheet steel;

b) 0.034 inch (0.86 mm) if of zinc-coated sheet steel; and

c) 0.045 inch (1.14 mm) if of copper, brass, or aluminum.

72.1.5 Enclosures thinner than those described in 72.1.4 that comply with the specifications of Table 11.3 or Table 11.4 (whichever applies) may be used if they are protected by an outer cabinet. Sheet steel cabinets and enclosures using panels consisting of more than one sheet of lesser thickness than specified

in 72.1.4 may be used if the construction is determined to be equivalent in all respects, including mechanical strength and corrosion resistance, to a single sheet of steel of the thicknesses stated in 72.1.4.

72.2 Corrosion protection

72.2.1 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion as specified in 72.2.2 and as determined by the applicable Corrosion Tests, Section 80.

72.2.2 An outer cabinet that protects motors, wiring, or enclosed current-carrying parts, and an inside enclosure that protects current-carrying parts other than motors shall comply with the requirements specified in:

a) 72.2.4, if the cabinet or enclosure is not less than 0.053 inch (1.35 mm) thick; or

b) 72.2.5, if it is of lesser thickness.

An outer cabinet that is the sole enclosure of current-carrying parts shall comply with the requirements specified in 72.2.5. (Minimum metal thicknesses are specified in Table 11.3.)

72.2.3 The requirements specified in 72.2.1, 72.2.2, and 72.2.4 – 72.2.6 are not applicable to a metal part, such as a decorative grille, that is not required to comply with this standard.

72.2.4 With reference to the applicable requirements specified in 72.2.2, one of the following coatings shall be used:

a) Hot-dipped, mill-galvanized sheet steel that complies with the coating Designation G90 in the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement. The weight of zinc coating may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-93. An A60 (alloyed) coating shall also comply with the requirements in 72.2.7.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel. The thickness of the coating shall comply with the requirements specified in 79.1(a) of the Metallic Coating Thickness Test, Section 79. An annealed coating shall also comply with the requirements in 72.2.7.

c) Protection equivalent to that afforded by G60 hot-dipped, mill-galvanized coating. See 72.2.6.

72.2.5 With reference to the applicable requirement specified in 72.2.2, one of the following coatings shall be used:

a) Hot-dipped, mill-galvanized sheet steel complying with the coating Designation G90 in the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, and has not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement. The weight of zinc coating may be determined by any method; however, in case of question the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-93.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel. The thickness of the coating shall comply with the requirements specified in 79.1(b) of the Metallic Coating Thickness Test, Section 79. An annealed coating shall also comply with the requirements in 72.2.7.

c) A cadmium coating. The thickness of coating shall comply with the requirement of 79.2.

72.2.6 With reference to 72.2.2 and 72.2.4(c), other finishes may be used if comparative tests with galvanized sheet steel indicate they provide equivalent resistance to corrosion. Such finishes include paints, special metallic finishes and combinations of the two. The steel, which is not to be annealed, wiped or given other surface treatment as part of the test, shall comply with the requirements of either 72.2.4(a) or 72.2.5(a), whichever is applicable.

72.2.7 Where the bending and forming process damages a coating already annealed on a surface, the bent or formed area shall be painted. The coating is considered to be damaged if flaking or cracking is visible at the outside radius of a bent or formed section viewed at 25-power magnification. This requirement applies specifically to any hot-dipped, mill-galvanized A60 (alloyed) coating or to any annealed-zinc coating.

72.2.8 Extruded and rolled edges and holes shall be painted in compliance with 72.2.7. However, simple sheared or cut edges and punched holes are not considered to be formed and need not be painted. Also, no paint is required on those inside surfaces of a cabinet or enclosure that are not touched by water during the Rain Test, Section 76.

72.2.9 Nonferrous cabinets and enclosures may be used without corrosion protection.

72.2.10 Nonmetallic cabinets and enclosures shall comply with the requirements in the Mechanical Strength Tests for Enclosures, Section 66, after being subjected to the Ultraviolet Light and Water Exposure Test, Section 81. Nonmetallic cabinets and enclosures containing openings and/or exposed terminals, switches, and the like that are subject to corrosive elements, shall also comply with the Corrosion Tests, Section 80.

72.2.11 If a gasket is required to seal electrical enclosures against the entrance of rain and condensate, it shall be held in place by mechanical fasteners or adhesives, except as specified in 72.2.12, and shall comply with the requirements in the Accelerated Aging Tests for Gaskets, Sealing Compounds, and Adhesives, Section 82. A gasket shall be neoprene, rubber or thermoplastic. Other materials may be used if they have properties determined to be equivalent.

72.2.12 A gasket need not be held by mechanical fasteners or adhesives if it cannot be displaced when the enclosure cover is removed or if it reengages as intended when the cover is replaced. Consideration is to be given to the manner in which the gasket is intended to be mounted in application.

73 Field-Wiring Connections

73.1 Openings provided for field-wiring connections shall be intended for connection of conduit and shall not be less than 7/8 inch (22.2 mm) in diameter. An opening shall be threaded unless it is located wholly below the lowest uninsulated live part within the enclosure, or the opening is sheltered to prevent water draining into the enclosure along the outside surface of a field-supplied wireway. Threaded holes for conduit shall be provided with a conduit end stop unless the thread is tapered.

74 Internal Wiring

74.1 The internal wiring shall be constructed and assembled so as to reduce the risk of electric shock when the product is exposed to weather.

74.2 Wiring material used to connect electrical component enclosures may be Type RW wire, or it may be appliance-wiring material specified in Group A of Table 74.1 and has equivalent moisture resistance to Type RW. The wiring shall be enclosed in rigid- or flexible-steel conduit, in electrical metallic tubing, or in moisture-resistant nonmetallic sheathed cable. Wiring material of the type specified in Group A of Table

74.1, installed in either rigid conduit or electrical metallic tubing with rain-tight fittings or in liquid-tight flexible metal conduit with suitable fittings, may be used. Cords of appliance wiring material as specified in Group B of Table 74.1, may also be used. Bushings, where used, are to be non-absorptive.

Table 74.1
Typical Wiring Materials

Group	Type of wire, cord, or cable	Wire size, AWG	Wire size, (mm^2)	Insulation thickness, inch	Insulation thickness, (mm)
A	AC, ACL, ACT, RF-2, FF-2, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, RUH, RUW, T, THW, XHHW, MTW, THW-MTW, THWN, PF, PGF, PFF, PGFF, TW, or thermoplastic appliance wiring material, with insulation thickness shown at the right corresponding to wire sizes indicated	10 and smaller	(5.3)	2/64	(0.8)
		8	(8.4)	3/64	(1.2)
		6	(13.3)	4/64	(1.6)
		4	(21.2)	4/64	(1.6)
		3	(26.7)	4/64	(1.6)
		2	(33.6)	4/64	(1.6)
		1	(42.4)	5/64	(2.0)
		1/0	(54.0)	5/64	(2.0)
		2/0	(67.0)	5/64	(2.0)
		3/0	(85.0)	5/64	(2.0)
		4/0	(107.2)	5/64	(2.0)
B	SO, ST, SPT-3, SJO, SJT, or appliance wiring material having thermoplastic or neoprene insulation, with insulation thicknesses shown at the right corresponding to the wire sizes indicated	18	(0.82)	4/64	(1.6)
		16	(1.3)	4/64	(1.6)
		14	(2.1)	5/64	(2.0)
		12	(3.3)	5/64	(2.0)
		10	(5.3)	5/64	(2.0)
		8	(8.4)	6/64	(2.4)
		6	(13.3)	8/64	(3.2)
		4	(21.2)	9/64	(3.6)
		2	(33.6)	10/64	(4.0)

74.3 The wiring assembly shall be constructed with supply conduit connections but without pipe thread compounds and located to exclude water from electrical enclosures when the product is subjected to the Rain Test, Section 76.

74.4 A wire not intended for use in wet locations, and all cords shall be routed and supported so as not to be immersed in water.

75 Components, Electrical Insulating Material

75.1 Nonabsorptive electrical insulation shall be used in the construction of electrical components. Untreated fiber is an example of a material that shall not be used. Vulcanized fiber on electrical components may be used if components are not wetted as a result of the Rain Test, Section 76.

PERFORMANCE

76 Rain Test

76.1 The section of the product exposed to weather shall withstand a rain exposure for 1 hour without creating a risk of electric shock or malfunctioning. After each exposure, the product shall have an insulation resistance between live parts and dead metal parts of not less than 50,000 ohms. Except as specified in 76.2 and 76.3, water shall not enter enclosures above the level of the lowest electrical component (insulated wire excepted).

Exception: This test is not required if after examination of construction and function it is determined that the product is fully encapsulated and it is not possible for water to enter the enclosure and contact live parts.

76.2 Motor windings may be judged on the basis of the insulation resistance and by the Dielectric Voltage-Withstand Test, Section 55, if the motor is within the product enclosure and is shielded from openings in the top of the enclosure.

76.3 Water may enter an enclosure above the lowest electrical component if the point of entrance is not in proximity to live parts and live parts are not wetted during the rain exposure.

76.4 The product is to be operated so that electrical components are energized and the product is tested under the conditions judged most likely to cause the admission of water into or onto electrical components. To accomplish this it may be necessary to operate the product under various modes of operation or to de-energize the product if this could cause more water to enter. In any case, each exposure is to last 1 hour. If more than one exposure is required, the product is to be prepared for test as indicated in 76.6 before the test is repeated.

76.5 Field-wiring connections are to be made in accordance with the wiring method specified by the manufacturer for the product. Openings intended to terminate conduit are to be sealed. Openings intended for the entry of a conductor or conductors for a low-voltage or power-limited circuit are not to be sealed unless seals are provided as part of the product. See 72.1.2 and 72.1.3.

76.6 Except as indicated in 76.7, the product is to be examined to determine that all electrical parts, including motor windings, are not wetted and that there is no accumulation of water within the enclosures of electrical parts prior to rain exposure.

76.7 Drying of the product prior to the second or subsequent exposure is not required if, without such preparation, the product complies with the requirement of 76.8.

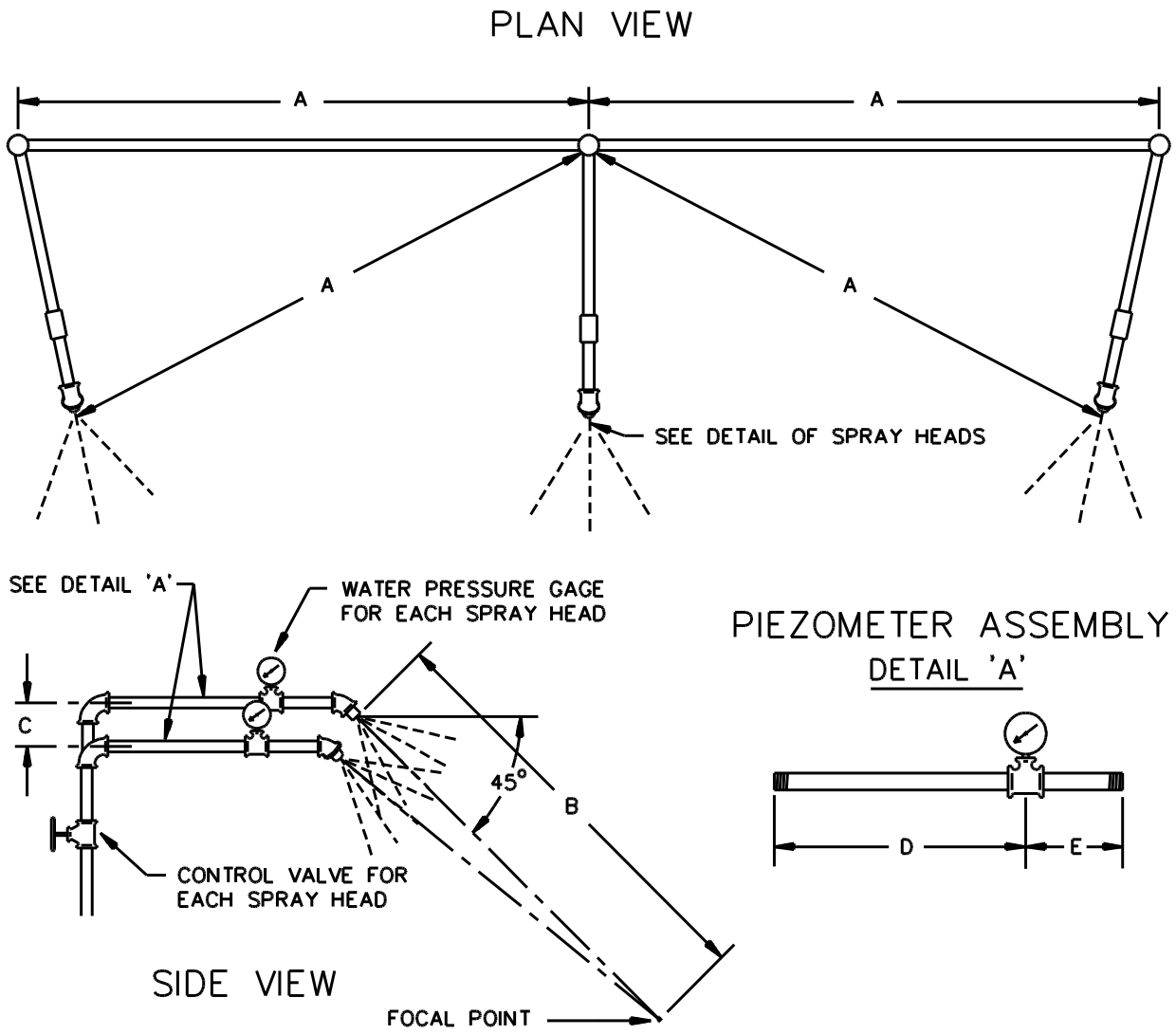
76.8 Insulation resistance is to be measured 1 minute after application of the voltage obtained by using the series-voltmeter method, or other means determined to be equivalent, and a DC circuit. After measurement of the insulation resistance, the complete unit is to be subjected to the Dielectric Voltage-Withstand Test, Section 55.

76.9 Insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms and by using a 250-volt DC circuit.

76.10 The rain test apparatus is to consist of three spray heads mounted in a water supply rack as shown in Figure 76.1. Spray heads are to be constructed in accordance with Figure 76.2. The water pressure for all tests is to be maintained at 5 psi (34.5 kPa) at each spray head. The unit is to be positioned in the focal area of the three spray heads so that the greatest quantity of water from the spray heads will enter the unit. The spray is to be directed at an angle of 45 degrees to the vertical toward the louvers or other openings closest to live parts.

Figure 76.1

Rain Test Apparatus

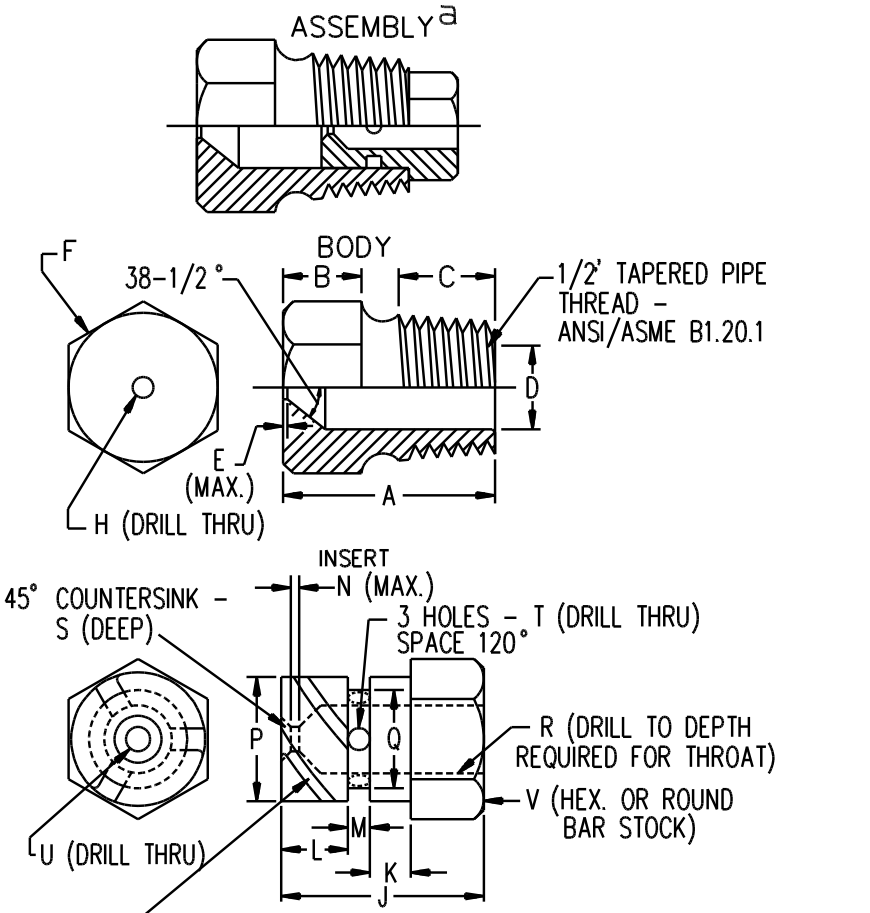


Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101D

Figure 76.2

Rain Test Spray Head



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35)[b]	2.80
H	(No.9)[b]	5.0	U	(No. 40)[b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain-Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional - To serve as a wrench grip.

RT100E

77 Dust Test

77.1 Operation of a product intended to be used outdoors shall not be impaired by an accumulation of dust as applicable.

Exception: This test is not required if after examination of construction and function it is determined that the product cannot be impaired by an accumulation of dust.

77.2 A de-energized sample in its intended mounting position is to be placed in an air-tight chamber having an internal volume of at least 3 cubic feet (0.085 m^3). Approximately 2 ounces (0.06 kg) of cement dust, maintained at 20 – 50 percent relative humidity and capable of passing through a 200 mesh screen, is to be circulated for 1 hour by means of compressed air or a blower so as to completely envelop the sample in the chamber. The air flow is to be maintained at an air velocity of approximately 50 feet per minute (0.25 m/s).

77.3 Following the exposure to dust, the product is to be removed carefully, mounted in its intended position, energized from a source of supply in accordance with 35.4.1, and shall comply with the requirements in the Normal Operation Tests, Section 39.

78 Variable Ambient Test – Outdoor Use

78.1 A product intended for outdoor use shall function as intended at rated voltage with its related equipment at ambient temperatures of minus 35 and plus 66 °C (minus 31 and plus 151 °F).

78.2 The exposure to each of the temperatures specified in 78.1 is to be 4 hours or more.

79 Metallic Coating Thickness Test

79.1 A zinc coating shall be uniformly applied to an average thickness of not less than:

a) 0.00041 inch (0.010 mm) and to a minimum thickness of 0.00034 inch (0.0086 mm) if the coating is specified in 72.2.4(b); or

b) 0.00061 inch (0.016 mm) and to a minimum thickness of 0.00054 inch (0.014 mm) if the coating is specified in 72.2.5(b).

79.2 The cadmium coating specified in 72.2.5(c) shall not be less than 0.001 inch (0.0025 mm) thick on both surfaces as determined by the test specified in 79.3 – 79.10.

79.3 The solution to be used for this test is to be made from distilled water and is to contain 200 grams of reagent-grade chromic acid (CrO_3) per liter of solution and 50 grams of reagent-grade concentrated sulfuric acid (H_2SO_4) per liter. The latter is equivalent to 27 milliliters of reagent-grade concentrated sulfuric acid per liter, specific gravity 1.84, containing 96 percent of H_2SO_4.

79.4 The test solution is to be contained in a glass vessel, such as a separatory funnel having an outlet equipped with a stopcock and a capillary tube of approximately 0.025 inch (0.64 mm) inside bore and 5.5 inch (140 mm) long. The lower end of the capillary tube is to be tapered to form a tip, the drops from which are to be approximately 0.05 milliliter each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops per minute. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

79.5 The sample and the test solution are to be kept in the test room long enough to acquire the room temperature, which is to be noted and recorded. The test is to be conducted at a room temperature of 70 – 90 °F (21 – 32 °C).

79.6 Each sample is to be cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of a solvent. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care is to be taken that the cleaned surface does not come in contact with the hands or any foreign material.

79.7 The sample is to be supported 0.7 – 1.0 inch (17.8 – 25.4 mm) below the orifice. The surface to be tested is to be inclined approximately 45 degrees from horizontal so that the drops of solution strike the point to be tested and run off.

79.8 After cleaning, the sample to be tested is to be placed under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stopwatch until the dropping solution dissolves the protective metallic coating and exposes the base metal. The end point is achieved with the first appearance of the base metal, which is made recognizable by a change in color.

79.9 Each specimen of a test lot is to be subjected to the test at three or more points on the inside surface and at an equal number of points on the outside surface where the metallic coating is expected to be the thinnest. Cut, stenciled and threaded surfaces are not to be tested as part of the inside surface. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

79.10 To calculate the thickness of the coating being tested, the thickness factor appropriate for the temperature at which the test was conducted is to be selected from Table 79.1 and then multiplied by the time in seconds required to expose base metal as determined in 79.8.

Table 79.1
Thickness of Coatings

Temperature,		Thickness factors, 0.00001 inch (0.0003 mm) per second,	
°F	(°C)	Cadmium platings	Zinc platings
70	(21.1)	1.331	0.980
71	(21.7)	1.340	0.990
72	(22.2)	1.352	1.000
73	(22.8)	1.362	1.010
74	(23.3)	1.372	1.015
75	(23.9)	1.383	1.025
76	(24.4)	1.395	1.033
77	(25.0)	1.405	1.042
78	(25.6)	1.416	1.050
79	(26.1)	1.427	1.060
80	(26.7)	1.438	1.070
81	(27.2)	1.450	1.080
82	(27.8)	1.460	1.085
83	(28.3)	1.470	1.095
84	(28.9)	1.480	1.100

Table 79.1 Continued on Next Page

Table 79.1 Continued

Temperature,		Thickness factors, 0.00001 inch (0.0003 mm) per second,	
°F	(°C)	Cadmium platings	Zinc platings
85	(29.4)	1.490	1.110
86	(30.0)	1.501	1.120
87	(30.6)	1.513	1.130
88	(31.1)	1.524	1.141
89	(31.7)	1.534	1.150
90	(32.2)	1.546	1.160

80 Corrosion Tests

80.1 General

80.1.1 A unit intended for outdoor/wet or damp locations shall operate as intended, or shall annunciate a trouble condition, after being subjected to the corrosive atmosphere tests described in 80.2 – 80.4 as applicable.

80.1.2 To simulate field activity, if requested by the manufacturer, samples may be operated for five cycles of alarm and reset each time a new charge of gas is introduced (see 80.3 and 80.4). The manufacturer may also request that the units are energized during the time between the gas changes, but otherwise, the units should remain completely un-powered throughout the test.

80.1.3 For products with metallic enclosures, or products with nonmetallic enclosures containing openings and/or exposed terminals, switches, and the like that are subject to corrosive elements, two (2) separate samples are to be subjected to each of the Corrosion Tests [six (6) samples total] and the Ultraviolet Light and Water Exposure Test, Section 81, as applicable. The samples are to be of identical size.

80.2 Salt spray (fog)

80.2.1 The apparatus for salt-spray (fog) testing is to consist of:

a) A fog chamber, the inside of which measures 48 by 30 by 36 inches (1.2 by 0.8 by 0.9 m);

b) A salt-solution reservoir;

c) A supply of conditioned compressed air;

d) A dispersion tower constructed in accordance with Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117-95, for producing a salt fog;

e) Sample supports;

f) Provision for heating the chamber; and

g) Necessary means of control.

80.2.2 The dispersion tower for producing a salt fog is to be located in the center of the chamber and is to be supplied with humidified air at a pressure of 17 – 19 psi (117 – 131 kPa) so that the salt solution is aspirated as a fine mist or fog into the interior of the chamber.

80.2.3 Common salt (sodium chloride) is to make up 5 percent of the weight of the salt solution, and the other 95 percent is to be contributed by distilled water. The pH value of the collected solution is to lie between 6.7 and 7.2, and its specific gravity is to be between 1.0255 to 1.0440 at 25 °C (77 °F). The temperature of the chamber is to be maintained at 35 plus 1 or minus 2 °C (95 plus 2 or minus 3 °F) throughout the test.

80.2.4 The test samples are to be suspended vertically in the test chamber for 240 hours (10 days).

80.2.5 Drops of solution that accumulate on the ceiling or on the cover of the chamber are to be diverted from dropping on the samples. Drops of solution that fall from samples are not to be recirculated but are to be removed by a drain located at the bottom of the chamber.

80.3 Moist hydrogen sulfide (H_2S) – air mixture

80.3.1 The test samples are to be supported as intended in service in a closed chamber having openings for gas inlet and outlet for 240 hours (10 days).

80.3.2 Hydrogen sulfide (H_2S) is to be supplied to the test chamber from a commercial cylinder containing this gas under pressure. An amount of hydrogen sulfide equivalent to 1 percent of the volume of the test chamber is to be introduced into the chamber each working day. Prior to the introduction of the gases each day, the remaining gas from the previous day is to be purged from the chamber. A small amount of water is to be maintained at the bottom of the chamber to maintain humidity levels. The chamber is to be maintained at room temperature during the test period.

80.4 Moist carbon dioxide (CO_2) – sulfur dioxide (SO_2) – air mixture

80.4.1 The test samples are to be supported as intended in service in a closed chamber having openings for gas inlet and outlet for 240 hours (10 days). A water jacket and thermostatically controlled heater are to be provided to maintain a temperature of 35 ±1 °C (95 ±2 °F).

80.4.2 Sulfur dioxide (SO_2) and carbon dioxide (CO_2) are to be supplied to the test chamber from commercial cylinders containing these gases under pressure. An amount of sulfur dioxide equivalent to 1 percent of the volume of the test chamber, and an equal volume of carbon dioxide are to be introduced into the chamber each working day. Prior to the introduction of the gases each day, the remaining gas from the previous day is to be purged from the chamber. A small amount of water is to be maintained at the bottom of the chamber for humidity.

80.5 Alternate corrosion test (21-Day)

80.5.1 The 21-day corrosion test outlined in 80.5.2 – 80.5.4 may be conducted in lieu of the corrosion tests noted in 80.2 – 80.4.

80.5.2 Two burglar alarm samples, one at maximum and one at minimum sensitivity setting (if applicable), are to be placed in a 200 liter or larger test chamber on a platform approximately 2 inches (50.8 mm) above the bottom of the chamber. The temperature in the chamber shall be maintained at 30 ±2 °C (86 ±3 °F) and the relative humidity at 70 ±2 percent (measured directly in the chamber). The temperature and humidity are to be checked daily. Because of the corrosive atmosphere a set of wet and dry bulb thermometers shall be used for measurement of relative humidity.

80.5.3 The following gas mixture in air is to be supplied to the chamber at a rate sufficient to achieve an air exchange in the chamber of about five times per hour, for a period of 3 weeks: 100 ±10 parts per billion (ppb) hydrogen sulfide (H_2S) plus 20 ±5 ppb chlorine (Cl_2) plus 200 ±50 ppb nitrogen dioxide (NO_2). The air inside the chamber is to be circulated by a single fan, with flow upwards from the bottom.

Note: parts per billion (ppb) = parts per 10^9 by volume

80.5.4 Following this test, the burglar alarm unit shall operate as intended, or shall annunciate a trouble condition.

81 Ultraviolet Light and Water Exposure Tests

81.1 A polymeric material used for (or as part of) the enclosure of a product intended for outdoor environments shall show no deterioration that may impair the intended performance of the product after being subjected to the following tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C:

a) The Ultraviolet Light Exposure Test; and

b) The Water Exposure and Immersion Tests.

Exception No. 1: These tests are not required for Recognized polymeric material rated "f1". Further examination is necessary for Recognized polymeric material rated "f2" to determine if one or both of these test can be waived.

Exception No. 2: With regard to (a), the examination of the property-retention parameters for a polymeric material not used as an enclosure, but attached to or exposed on the outside of the product such as a viewing window, need only include dimensional change with regard to affecting the water seal, and translucence such that viewing of required information is prohibited.

82 Accelerated Aging Tests for Gaskets, Sealing Compounds, and Adhesives

82.1 Neoprene or a rubber compound (foamed material accepted) shall be previously subjected to the applicable tests in the Standard for Gaskets and Seals, UL 157, or shall have the physical properties as specified in Table 82.1 before and after accelerated aging under the conditions indicated in Table 82.2 if a gasket or sealing compound made from the material is used to bring an electrical enclosure into compliance with the requirements in the Rain Test, Section 76.

Table 82.1
Physical Properties

Property	Neoprene or rubber compound		Polyvinyl-chloride materials	
	Before test	After test	Before test	After test
Recovery – maximum set when 1 inch (25.4 mm) gage marks are stretched to 2.5 inches (63.5 mm), held for 2 minutes and measured 2 minutes after release	1/4 inch (6.4 mm)	–	Not specified	Not specified
Elongation – minimum increase in distance between 1 inch gage marks at break	250 percent (1 – 3.5 inches) (25.4 – 89.0 mm)	65 percent of original	250 percent (1 – 3.5 inches) (25.4 – 89.0 mm)	75 percent of original
Tensile strength – minimum force at breaking point	850 psi (5.86 MPa)	75 percent of original	1200 psi (8.27 Mpa)	90 percent of original

Table 82.2
Accelerated Aging Test Criteria

Measured temperature rise, °C	Material	Test program
35	Rubber or neoprene	70 hours in an air-circulating oven at 100 ±1 °C (212 ±1.8 °F)
35	Thermoplastic	168 hours in an air-circulating oven at 87 ±1 °C (189 ±1.8 °F)
50	Rubber or neoprene	168 hours in an air-circulating oven at 100 ±1 °C (212 ±1.8 °F)
50	Thermoplastic	240 hours in an air-circulating oven at 100 ±1 °C (212 ±1.8 °F)
55	Rubber, neoprene, or thermoplastic	168 hours in an air-circulating oven at 113 ±1 °C (235.4 ±1.8 °F)
65	Rubber or neoprene	240 hours in an air-circulating oven at 121 ±1 °C (249.8 ±1.8 °F)
65	Thermoplastic	168 hours at 121 ±1 °C (249.8 ±1.8 °F) or 1440 hours at 97±1 °C (206 ±1.8 °F) in an air-circulating oven
80	Rubber, neoprene, or thermoplastic	168 hours in an air-circulating oven at 136 ±1 °C (276.8 ±1.8 °F)

82.2 A sealing compound shall not melt, become brittle, or otherwise deteriorate to a degree that will impair its sealing properties as determined by comparing an aged sample to an unaged sample. See 82.7 for test procedure.

82.3 Gaskets or materials other than those mentioned in 82.1 and 82.2 shall be nonabsorptive and provide the resistance to aging and temperatures specified in 82.1 and 82.2.

82.4 Where a gasket is secured by an adhesive, the force required to peel the gasket from its mounting surface after exposure to aging and immersion conditions specified in 82.8 shall not be less than:

a) 50 percent of the force required to peel off gaskets fixed to "as received" samples; and

b) 2 pounds (8.82 N) for each inch (25.4 mm) of gasket width.

82.5 Thermoplastic material shall not deform, melt, or otherwise deteriorate to a degree that will impair its sealing properties when subjected to accelerated aging conditions specified in Table 82.2. Solid PVC gasket material shall have physical properties indicated in Table 82.1 before and after the accelerated aging.

82.6 Tensile strength and elongation are to be determined using the test methods and apparatus described in the Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension, ASTM D412-92.

82.7 A sealing compound is to be applied to the surface it is intended to seal. A representative sample of the surface with the sealing compound applied is to be subjected to accelerated aging under the conditions indicated in Table 82.2 for air-circulated oven exposure.

82.8 Where gaskets are secured by adhesives, samples of the gasket adhesive and mounting surface are to be subjected to:

a) Accelerated aging under the conditions indicated in Table 82.2 for air-circulated oven exposure; and

b) Immersion in distilled water for 72 hours.

82.9 Alternate method for gaskets – where the gasket is only available in an end use form not allowing for the ASTM D412-92 shape to be used, the method described in 82.10 and 82.12 may be used in lieu of the requirements of 82.1 – 82.8.

82.10 Three (3) specimens of a gasket of elastomeric materials such as neoprene, rubber, neoprene composition, rubber composition or flexible cellular material used to prevent the entry of water into a product shall be subjected to an accelerated aging test as specified in Table 82.3. Results are identified as satisfying the requirements in 72.2.11 when, following the test, there is no visible evidence of deterioration such as cracking after flexing, shrinkage, distortion, softening, hardening, or similar deterioration to an extent that affects the integrity of the seal intended to be provided by the material, when compared to unaged samples.

Table 82.3
Accelerated Aging Conditions

Measured temperature rise[a]				
More than,		Not more than,		
°F	(°C)	°F	(°C)	Test program[b]
0	(0)	63	(35)	Air-circulating oven aging for 70 hours at 212 °F (100 °C)
63	(35)	90	(50)	Air-circulating oven aging for 168 hours at 212 °F (100 °C)
90	(50)	99	(55)	Air-circulating oven aging for 168 hours at 235 °F (113 °C)
99	(55)	117	(65)	Air-circulating oven aging for 240 hours at 250 °F (121 °C)
117	(65)	144	(80)	Air-circulating oven aging for 168 hours at 277 °F (136 °C)
144	(80)	216	(120)	Air-circulating oven aging for 1440 hours at 320 °F (150 °C)
216	(120)	225	(125)	Air-circulating oven aging for 1440 hours at 316 °F (158 °C)
225	(125)	234	(130)	Air-circulating oven aging for 1440 hours at 327 °F (164 °C)
234	(130)	252	(140)	Air-circulating oven aging for 1440 hours at 345 °F (174 °C)
252	(140)	270	(150)	Air-circulating oven aging for 1440 hours at 363 °F (184 °C)
270	(150)	288	(160)	Air-circulating oven aging for 1440 hours at 381 °F (194 °C)
288	(160)	306	(170)	Air-circulating oven aging for 1440 hours at 399 °F (204 °C)
306	(170)	315	(175)	Air-circulating oven aging for 1440 hours at 410 °F (210 °C)
315	(175)	333	(185)	Air-circulating oven aging for 1440 hours at 428 °F (220 °C)
333	(185)	351	(195)	Air-circulating oven aging for 1440 hours at 446 °F (230 °C)
351	(195)	369	(205)	Air-circulating oven aging for 1440 hours at 464 °F (240 °C)
369	(205)	387	(215)	Air-circulating oven aging for 1440 hours at 482 °F (250 °C)
387	(215)	405	(225)	Air-circulating oven aging for 1440 hours at 500 °F (260 °C)

[a] Maximum temperature rise measured on the material during the temperature test.

[b] Air-circulating oven temperatures specified have a tolerance of ±3.6 °F (±2 °C).

82.11 As indicated in 82.12, a low temperature test is to be conducted on gaskets comprised of solid elastomer material, and both open and closed flexible cellular material, utilized in products intended for outdoor use.

82.12 Three specimens of the gasket are to be subjected to 24 ±1/2 hours at minus 40 ±3.6 °F (minus 40 ±2 °C). While at the test temperature, each specimen is to be bent within 5 seconds around the 0.25 inch (6.4 mm) mandrel to form a "U" bend. To minimize heat transfer to the specimen or "O" ring segment, gloves are to be worn. Each specimen is to be examined for evidence of cracking. Following the test, there shall be no visible evidence of deterioration such as cracking after flexing, shrinkage, distortion, softening,

hardening, or similar deterioration to an extent that affects the integrity of the seal intended to be provided by the material, when compared to unconditioned samples.

ACCESSORY EQUIPMENT

83 General

83.1 Accessory equipment shall comply with the requirements in 83.2 – 83.3, 84.1 – 84.4, and 85.1 – 85.4, in addition to the requirements in the preceding sections of this standard.

83.2 For the purposes of these requirements, accessory equipment is defined as equipment designed to be attached or added to a burglar alarm unit by qualified service personnel and is of such size that it may be marked for identification by a catalog number or its equivalent. Accessory equipment usually is dependent upon a basic unit of a system for mechanical support, electrical input, or both, and may or may not, by itself, perform a complete function.

83.3 The term "accessory equipment" is not intended to cover individual items of circuitry or components that, for reasons of improving, modifying, or repairing the product, are added to the product subsequent to the time of initial assembly, and that lose their identity in the process.

84 Construction

84.1 Accessory equipment shall be constructed so that it can be added to a product without creating a risk of fire, electric shock, or injury to persons.

84.2 The installation of accessory equipment shall:

a) Permit the mechanical positioning to be accomplished by common hand tools, such as screwdrivers, hexagonal wrenches, and the like, or by special tools provided by the manufacturer as a part of the installation kit; and

b) Permit the electrical connections to be accomplished by making use, wherever possible, of existing terminals and connections in the product.

84.3 The requirement in 84.2 does not preclude the addition, removal, or rerouting of insulated conductors to accomplish the desired installation as long as the alterations in the wiring can be accomplished by reference to installation instructions, and do not require the use of makeshift or substitute parts not used in the basic construction of the product.

84.4 All wiring provided as a part of an item of accessory equipment or related to its installation shall be rated for use at the highest voltage and temperature encountered in the area in which the wire is to be installed.

85 Performance (Installation) Test

85.1 Each item of accessory equipment shall have instructions that provide a step-by-step outline of the mechanical and electrical alterations necessary for intended installation and operation. The instructions shall be provided either on, or packed with, each item of accessory equipment, or shall be included in the system manual.

85.2 Each piece of accessory equipment shall be installed in its intended manner on or in conjunction with the product for which it is intended, by following the instructions provided by the manufacturer.

85.3 With the item of accessory equipment installed and operating, the burglar alarm control unit/system shall comply with the requirements in this standard.

85.4 Faults on accessory equipment shall not affect the burglar alarm system as defined by normal operation of the system equipment.

MANUFACTURING AND PRODUCTION LINE TESTS FOR HIGH-VOLTAGE PRODUCTS

86 General

86.1 The manufacturer shall provide the necessary production control, inspection and tests. The program shall include at least the Production Line Dielectric Voltage-Withstand Test, Section 87, and the Production Line Grounding Continuity Test, Section 88. A record shall be maintained of accepted products and their serial numbers or equivalent.

87 Production Line Dielectric Voltage-Withstand Test

87.1 Each product rated at more than 30 volts AC rms (42.4 volts DC or AC peak) shall withstand, without breakdown, as a routine production-line test, the application of an essentially sinusoidal AC potential of a frequency within the range of 40 – 70 hertz, or a DC potential, between high-voltage live parts and the enclosure, high-voltage live parts and exposed dead metal parts, and live parts of circuits operating at different potentials or frequencies.

The test potential is to be:

a) For a product rated at 150 volts AC rms or less – either 1000 volts (1414 volts, if a DC potential is used) applied for 60 seconds or 1200 volts (1697 volts, if a DC potential is used) applied for 1 second.

b) For a product rated at more than 150 volts – either 1000 volts plus twice the rated AC rms voltage (1414 volts plus 2.828 times the rated AC rms voltage, if a DC potential is used) applied for 60 seconds or 120 volts plus 2.4 times the rated AC rms voltage (1697 volts plus 3.394 times the rated AC rms voltage, if a DC potential is used) applied for 1 second.

87.2 If a product employs both high-voltage and low-voltage circuits, the test is to be conducted with the low-voltage circuit connected to the cabinet, chassis, or other dead metal part so that the potential applied between the high-voltage live parts and dead metal parts will simultaneously be applied between high-voltage live parts and low-voltage circuits.

Exception: The test potentials may be applied between the primary and core of all high-voltage input transformers located within the product. Other high-voltage components and wiring shall be visually examined to verify that required spacings have been maintained to the enclosure or other dead metal parts.

87.3 A printed wiring assembly or other electronic circuit component that would be damaged by the application of, or would short-circuit, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. A representative subassembly may be tested instead of an entire unit. Rectifier diodes in the power supply may be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

87.4 A 500 volt-ampere or larger transformer, the output voltage of which can be varied, is to be used to determine compliance with 87.1. The requirement of a 500 volt-ampere or larger transformer can be waived if the high potential testing equipment used is such that it maintains the specified voltage at the unit during the test.

87.5 The test equipment is to include a visible indication of the application of the test potential and an audible or visible indication, or both, of breakdown. In the event of breakdown, manual reset of an external switch is required, or an automatic reject of the unit under test is to result. Other arrangements may be considered and accepted if found to achieve the results contemplated.

87.6 If the charging current through a capacitor or capacitor type filter connected across the line, or from line to earth ground, is sufficient to prevent maintenance of the specified AC test potential, the unit is to be tested using a DC test potential in accordance with 87.1.

88 Production Line Grounding Continuity Test

88.1 The manufacturer shall test each high-voltage product having a power supply cord to verify electrical continuity between the device and the grounding blade of the attachment plug. See Grounding, Section 18.

88.2 This test is also required for permanently-connected units, sections of units, or both, and for accessories of such units that derive high-voltage power by means of cord and plug connection.

88.3 An indicating device such as an ohmmeter, low-voltage battery-and-buzzer combination, or the like, may be employed in establishing compliance with these requirements.

88.4 If the initial investigation of the product determines that internal parts are bonded to the frame and enclosure of the unit, a test that verifies the electrical continuity between the grounding blade of the supply and the frame or enclosure of the product is sufficient for establishing compliance with the requirement in 88.1.

MARKINGS

89 General

89.1 Unless otherwise indicated, a burglar alarm unit shall be plainly and permanently marked where it will be readily visible after installation, with the following information:

a) Manufacturer’s or private labeler's name or identifying symbol.

b) Date of manufacture by day, week, month, or quarter, AND year, which may be abbreviated or in an established or otherwise acceptable code.

c) Model number or equivalent.

d) Electrical ratings: input and output circuits:

1) AC or DC Powered Units – Rated voltage; amperes, watts, or volt-amperes; and frequency (AC only).

2) Battery Powered Units – Rated voltage, polarity, type and number of batteries to be used.

e) Mounting position if a product is intended to be mounted in a specific position.

f) Rating of each fuse, which is required to comply with the requirements of this standard; located in close proximity to the fuseholder.

g) Reference to the product installation instructions, if not attached to the product, by document number, and issue date and/or revision level. See Section 91.

h) Standby batteries (separately provided) – rated voltage, type, and number to be used, ampere-hour rating for rechargeable batteries, recommended replacement, and estimated life or a method of testing battery condition.

i) Standby batteries (integral) – type and number to be used, recommended replacement, and estimated life or a method of testing battery condition.

j) For units using nonrechargeable batteries, the manufacturer's name and model number shall be clearly marked on the unit near the battery compartment or in the installation instructions.

k) For a primary or secondary battery, the recommended battery maintenance and replacement instructions, as well as any specific test instructions to determine its capacity. See 57.2.7.

l) For an end-of-line device, the name or trademark of the manufacturer and model number. This marking may be on a tag secured to the device.

m) For accessories other than the end-of-line devices, the name or trademark of the manufacturer, model number, and electrical rating in volts, amperes or volt-amperes/watts, and frequency if separately powered, and reference to the installation wiring diagram when not attached to the product:

n) For cord and plug-in transformer-connected products, the following or equivalent wording: "Do Not Connect To A Receptacle Controlled By A Switch."

o) For a combination product, identification with respect to its functions.

p) Identification and function of lights, switches, meters, and the like, located adjacent to the component.

q) Information necessary for the operation of any manually operated part or the performance of a required test by the operator.

r) Specific environmental precautions to be taken. See 48.1, 49.1.

Exception No. 1: The marking in (d), (e), (h), (i), (j), (n), and (r) may be on a separate installation diagram if so referenced on the product.

Exception No. 2: Items (b), (c), (d), (e), (g), (n), and (r) may be marked on the inside of the unit if the marking is visible when the unit is opened for servicing.

Exception No. 3: (q) does not apply to holdup alarm initiating devices.

89.2 Use of the product. The following markings shall be present on the product(s), visible after installation:

a) For a control unit, the word "Commercial", followed by "Burglar Alarm Control Unit", or equivalent. For products other than a control unit, the marking shall consist of the words "Commercial Burglar Alarm", followed by a specific use description such as "Keypad", Power Supply", Communicator", or other appropriate wording. In addition, separately shipped parts or components of a complete product shall be identified as a "subassembly". The marking can be located on the inside of the unit if the unit is opened when serviced.

b) A marking to identify the application(s) of the product (e.g. central station, local, police station, proprietary, holdup alarm, mercantile, mercantile safe and vault, bank safe and vault) shall be visible after installation. The marking can be located on the inside of the unit if the unit is opened when serviced.

c) For a control unit and/or off-premises communicator, a marking to identify the transmission function of the product (e.g. DACT, Multiplex, PSDN, dual path transmission, standard line security, encrypted line security, remote access). The marking can be located on the inside of the unit if the unit is opened when serviced.

89.3 Marking on the product shall specifically identify all power-limited circuits by terminal designation. This marking may be on a separate installation wiring diagram if so referenced on the product.

Exception: When the product is of a modular construction and compliance with 89.3 cannot be achieved or would be inappropriate, marking on the product shall identify all modules and the associated circuits that are power-limited.

89.4 Wiring and mounting instructions shall be provided with each product. The instructions may be:

a) Attached to the product; or

b) Separate from the product if they are referenced in the marking attached to the product.

89.5 An installation wiring diagram shall be attached to the product or referenced in the product marking, and shall indicate the evaluated devices and circuits that may be used for connection to the control unit in the field. If a special tool is required for connection of field wiring, the installation wiring diagram shall identify the tool by manufacturer and model number or equivalent, along with information as to where the tool may be obtained.

89.6 Unless the correct wiring connections are evident, installation wiring terminals or wire leads shall be marked to indicate the connections. When connections are not indicated on the unit, the terminals or leads shall be numbered, colored, or otherwise indicated, and markings on the unit shall correlate with the installation wiring diagram/instructions.

89.7 A product intended for permanent connection to a wiring system other than a metal-enclosed system shall be marked to indicate the system(s) to which it is intended to be connected. The marking shall be located so that it will be visible when power connections are being made to the product.

89.8 If a manufacturer produces a unit at more than one factory, each product shall have a distinctive marking to identify it as the product of a particular factory.

89.9 If a warning notice is marked on a product, the letter height shall not be less than 7/64 inch (2.8 mm) for a signal word, such as "DANGER," "WARNING," or "CAUTION," and not less than 3/32 inch (2.4 mm) for the remainder of the notice.

89.10 If replacing lamps or fuses, resetting circuit breakers, or any other service function exposes persons to the risk of unintentional contact with high-voltage live parts or telephone circuits, the product shall be marked to indicate that such servicing is to be performed only while the equipment is electrically disconnected from the branch-circuit supply and/or telephone terminals. The following marking or equivalent shall be located on the outside cover that requires opening for such servicing: “Disconnect Power Prior to Service”.

89.11 There shall be legible and durable marking for each fuse required to comply with the requirements in this standard indicating the ampere rating (and voltage rating if more than 125 volts) of the fuse to be used for replacement. The marking is to be located so that it is obvious to which fuse or fuseholder the marking applies. In addition, the following prominent marking shall be provided (a single marking may be used for a group of fuses) where it will be clearly visible to persons replacing fuses:

"WARNING – For Continued Protection Against the Risk of Fire, Replace Only With Same Type and Rating of Fuse."

89.12 If a separate grounding conductor is necessary as part of the installation wiring for a product, a marking shall be included on the product to indicate this fact, and shall refer to the installation instructions unless complete instructions are attached to the product.

89.13 If the wires in a terminal box or compartment of a product intended for power-supply connections attain a temperature higher than 60 °C (140 °F) during the Temperature Test, Section 56, the unit shall be marked "For supply connections, use wires rated for at least ____°C (____°F)," or with an equivalent statement at or near the point at which the supply connections are to be made. The temperature to be used in this marking shall be as indicated in Table 89.1. The marking shall be located so that it will be readily visible during and after installation of the product.

Table 89.1
Temperature for Marking

Temperature attained in terminal box or compartment		Temperature in marking	
°C	(°F)	°C	(°F)
61 – 75	(142 – 167)	75	(167)
76 – 90	(168 – 194)	90	(194)

89.14 A unit or accessory that has been investigated and determined to be suitable for outdoor use shall be legibly marked with the wording “Outdoor Use” or equivalent on a near the marking plate.

89.15 In accordance with footnote (b) of Table 50.1, cord-connected equipment provided with an electromagnetic radiation suppression filter and having a leakage current in excess of 0.5 or 0.75 mA (whichever applies) but less than 2.5 mA, shall be marked "WARNING – To reduce the risk of electric shock this equipment is provided with a grounding type power-supply cord. Connect equipment to a grounded receptacle," or the equivalent.

89.16 The subassemblies of a product, intended to be shipped separate from the product, shall be marked with the name or trademark of the manufacturer, model number or other designation determined to be equivalent, and reference to the installation wiring diagram by document number and issue date and/or revision level if not attached to the subassembly. When the product completely consists of subassemblies that are to be shipped separately, a minimum of one of the subassemblies that will be used in each product configuration shall be marked with the information required by 89.1(d) and 89.2.

89.17 A marking shall be provided adjacent to push-in terminals to indicate that copper conductors only are to be used. See 17.3.1(d).

89.18 A product intended for installation in air handling spaces and complying with 1.9.6 shall be marked "Suitable for Use In Air Handling Spaces" or "Suitable for Use in Other environmental Air Space" in Accordance with Section 300.22, (C) of the National Electrical Code."

89.19 Additional marking requirements as specified in 10.2.2, 10.2.3(b), 16.3, 16.8, 18.5, 18.6, and 42.4.

90 Marking Permanency Tests

90.1 All markings shall be permanent. Markings affixed to a product shall be sufficiently durable as to resist the deleterious effects of handling, cleaning agents, and the like expected in the intended use in accordance with 90.2.

90.2 Directly applied markings, or an external marking plate secured by cement or adhesive, shall comply with the applicable portions of the Standard for Marking and Labeling Systems, UL 969.

90.3 A marking on outdoor use equipment is to be of corrosion resistant material.

90.4 Among the factors taken into consideration when evaluating the acceptability of a marking attached by adhesives is the resistance of the marking to defacement or removal at temperatures and in atmospheres to which it may be subjected under conditions of use.

INSTALLATION AND OPERATING INSTRUCTIONS

91 General

91.1 Installation and operating instructions shall be provided with each product. The instructions may be incorporated on the inside of the product, on a separate sheet, or as part of a manual. If not included directly on the product, the instructions or manual shall be referenced in the marking information on the product. See Markings, Section 89.

91.2 The installation wiring diagram(s) and any special field installation instructions shall be attached to the unit or, when separate, shall be provided with the product or within the installation instructions provided with the product. A copy shall be supplied with each individual product or with each single shipment when multiples of the same products are shipped directly (to an end customer) in a single shipment.

91.3 The installation instructions containing the information required in Sections 91 and 92 shall be made available by one or more of the following means:

a) Printed hardcopy format;

b) Installation wiring diagram/instructions attached to the product;

c) Electronic instructions within the basic product software; or

d) Electronic media such as CD, DVD, thumb drive, website, or equivalent.

91.4 When the installation instructions are included as described in 91.3 (a), (c), or (d), the installation instructions shall be referenced in the product marking by document number AND issue date and/or revision level. Products utilizing electronic media as described in 91.3 (c) or (d), shall include information on how to receive a printed copy of the installation instructions.

91.5 The instructions shall include at least the following:

a) Name or trademark of manufacturer.

b) Each applicable product model number as appropriate.

c) Document number, AND issue date and/or revision level.

d) Electrical ratings for all input and output circuits.

e) Typical installation drawing layouts and a complete representative installation wiring diagram(s) for the product(s) indicating recommended locations and specific reference that wiring methods used shall be in accordance with the National Electrical Code, ANSI/NFPA 70, the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681, and the Standard for Central-Station Alarm Services, UL 827, as applicable. Locations where installations are not recommended shall also be included.

f) Description of the product operation including, but not limited to, the following functions, as applicable:

- Normal standby;
- Alarm;
- Alarm test;
- Alarm silence;
- Alarm reset;
- Trouble;
- Trouble silence;
- Arm;
- Disarm;
- Acknowledgment signal;
- Primary and/or secondary off-premises communication paths;
- Primary/secondary power sources;
- Off-normal position of switches;
- Functions of lights and switches;
- Remote access intended functionality and limitations.

g) Concise description of the operation, programming, testing, and maintenance procedures for the product(s), and recommended testing frequency that shall be at least once per year.

h) Identification of replacement parts, such as lamps or batteries, by a part number, manufacturer's model number, or the equivalent.

i) A troubleshooting section including a description of the conditions that might be expected to result in false alarms or impaired operation of the product(s).

j) A description of any features provided to reduce the risk of fire, electric shock, or injury to persons and a warning against bypassing such features.

k) Power over communications cable equipment that meets the requirements of this Standard shall specify the equipment with which it is compatible with.

l) The essential information noted in 92.1.

92 Essential Information

92.1 As applicable, the following sections contain essential information that shall be provided in the installation instructions:

1) Section 8, Version Number;

2) 17.2.2, field wiring terminals;

3) 17.3.1(c), quick-connect terminals;

4) 17.3.2 (a) – (c), field wiring terminal construction;

5) 17.4, field wiring leads;

6) 17.5, power-limited circuits;

7) 31.1(c), end-of-line devices;

8) 36.4, Power Over Communications Cable Equipment;

9) Section 37, Software-Based Receiving Equipment;

10) Section 38, Remote Access;

11) Section 39, Normal Operation;

12) Section 40, Communication Operation;

13) 41.3, “AC power on” indicator

14) 44.7, special application circuits

15) 45.1.1, 45.1.7, power-limited circuits;

16) 46.5, loop impedance;

17) Section 48 and 78, variable ambient conditions;

18) Section 49, humidity conditions;

19) 57.2.8 battery precautions;

20) 59.4.1 – Exception, 59.4.8, input/output circuit transients;

21) 60.3 – Exception, radio frequency interference

22) 61.1 – Exception, ac induction;

23) 68.2.3, 68.3.2, 68.4.2, 68.5.2, 89.5, installation tools;

24) 69.2.1, 69.14.1, 69.16.1, radio-frequency (RF) specifications;

25) 84.3, 84.4, accessory wiring;

26) 85.1, 85.2, accessory installation;

27) 89.1 – Exception No. 1, marking reference;

28) 89.4 – 89.6, wiring and mounting; and

29) 89.12, separate grounding conductor.

APPENDIX A
Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard − UL Standard Designation

Access Control System Units – UL 294
Appliance Wiring Material – UL 758
Attachment Plugs and Receptacles – UL 498
Audible Signal Appliances – UL 464
Audio, Video and Similar Electronic Apparatus – Safety Requirements – UL 60065
Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar General Use – UL 6500
Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements – UL 62368-1
Battery Chargers for Charging Engine-Starter Batteries – UL 1236
Burglary Resisting Glazing Material – UL 972
Central-Station Alarm Services – UL 827
Central-Station Automation Systems – UL 1981
Communications Cables – UL 444
Communications-Circuit Accessories – UL 1863
Component Connectors for Use in Data, Signal, Control and Power Applications – UL 1977
Conduit, Tubing and Cable Fittings – UL 514B
Connectors and Switches for Use with Burglar-Alarm Systems – UL 634
Control Units and Accessories for Fire Alarm Systems – UL 864
Cord Sets and Power-Supply Cords – UL 817
Double Insulation Systems for Use in Electrical Equipment – UL 1097
Electrically Isolated Semiconductor Devices – UL 1557
Electromagnetic Interference Filters – UL 1283
Enclosures for Electrical Equipment, Non-Environmental Considerations – UL 50
Enclosures for Electrical Equipment, Environmental Considerations – UL 50E
Extruded Insulating Tubing – UL 224
Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces – UL 2043
Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains – UL 60384-14
Flexible Cords and Cables – UL 62
Fuseholders – UL 4248 series
Gaskets and Seals – UL 157
Hosted Central Station Services – UL 827A
Household and Commercial Batteries – UL 2054
Household Burglar-Alarm System Units – UL 1023
Household Fire Warning System Units – UL 985
Industrial Control Equipment – UL 508
Information Technology Equipment – Safety – Part 1: General Requirements – UL 60950-1
Installation and Classification of Burglar and Holdup Alarm Systems – UL 681
Insulating Bushings – UL 635
Intrusion-Detection Units – UL 639
Key Locks – UL 437
Lithium Batteries – UL 1642
Low-Voltage Switchgear and Controlgear – UL 60947 series
Low Voltage Transformers – Part 1: General Requirements – UL 5085-1
Low Voltage Transformers – Part 2: General Purpose Transformers – UL 5085-2
Low Voltage Transformers – Part 3: Class 2 and 3 Transformers – UL 5085-3
Marking and Labeling Systems – UL 969
Metallic Outlet Boxes – UL 514A
Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures – UL 489

Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers – UL 514C
Optical Isolators – UL 1577
Plastic Materials for Parts in Devices and Appliances, Tests for Flammability of – UL 94
Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards – UL 746E
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Power Supplies for Fire-Protective Signaling Systems – UL 1481
Power Units, Class 2 – UL 1310
Power Units Other Than Class 2 – UL 1012
Printed Wiring Boards – UL 796
Protectors for Data Communications and Fire Alarm Circuits – UL 497B
Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape – UL 510
Secondary Protectors for Communications Circuits – UL 497A
Sharpness of Edges on Equipment, Tests for – UL 1439
Single- and Multi-Layer Insulated Winding Wire – UL 2353
Software Cybersecurity for Network-Connectable Products, Part 1: General Requirements – UL 2900-1
Software Cybersecurity for Network-Connectable Products, Part 2-3: Particular Requirements for Security and Life Safety Signaling Systems, Outline – UL 2900-2-3
Supplementary Protectors for Use in Electrical Equipment – UL 1077
Surge Protective Devices – UL 1449
Switches, Clock-Operated – UL 917
Switches, General-Use, Snap – UL 20
Switches, Special-Use – UL 1054
Switches for Appliances – Part 1: General Requirements – UL 61058-1
Systems of Insulating Materials – General – UL 1446
Temperature-Indicating and -Regulating Equipment – UL 873
Terminal Blocks – UL 1059
Terminals, Electrical Quick-Connect – UL 310
Thermal-Links for Use in Electrical Appliances and Components – UL 60691
Thermistor-Type Devices – UL 1434
Transformers, Specialty – UL 506
Tubing, Extruded Insulating – UL 224
Uninterruptible Power Systems – UL 1778
Wire Connectors – UL 486A-486B
Wires and Cables, Thermoplastic-Insulated – UL 83
Wires and Cables, Thermoset-Insulated – UL 44

APPENDIX B
(Informative)

B1 Power over Ethernet (PoE) Reference

B1.1 Definitions

B1.1.1 PoE – A generic term referring to equipment per the Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements, IEEE 802.3af. Note PoE is often used to denote generically PoE or PoE+.

B1.1.2 PoE+ – A generic term referring to equipment per the Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements, IEEE 802.3at.

B1.2 Ratings (Per Pair)

B1.2.1 NOMINAL VOLTAGE – The generally understood voltage supplied by the power sourcing equipment (PSE) at its output terminals when operated in 'source' mode (e.g. continuous operation), and the voltage applied to the input terminals of the powered device (PD). The voltage range for PoE is 44 to 57 V DC with nominal voltage of 48 volts DC. For PoE+, the voltage range is 50 to 57 V DC with a nominal voltage of 53 Volts DC.

B1.2.2 NOMINAL CURRENT – PoE typically provides up to 350 mA of current; PoE+ provides up to 600 mA.

B1.2.3 NOMINAL POWER – PoE typically delivers up to 15.4 W of power; PoE+ delivers up to 30.0 W.

B1.3 Publications

IEEE 802.3af-2003, *Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Amendment: Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI) Enhancements*

IEEE 802.3at-2009, *Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements*

ANSI/NFPA 70, *National Electrical Code*

ANSI/TIA-568-C.2, *Balanced Twisted-Pair Telecommunications Cabling and Components*

333 Pfingsten Road
Northbrook, Illinois 60062–2096
847.272.8800

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