UL 864

ISBN 0-7629-0795-9

Control Units and Accessories for Fire Alarm Systems

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Control Units and Accessories for Fire Alarm Systems, UL 864

Ninth Edition, Dated September 30, 2003

Revisions: This Standard contains revisions through and including May 29, 2007.

Summary of Topics

The revisions dated May 29, 2007 were issued to postpone the effective date, for the clauses indicated in this standard, until December 31, 2008.

UL Standards for Safety are developed and maintained in the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Due to formatting differences resulting from the use of UL's new electronic publishing system, please note that additional pages (on which no requirements have been changed) may be included in revision pages due to relocation of existing text and reformatting of the Standard.

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The following table lists the future effective dates with the corresponding item.

Future Effective Date	References
December 31, 2008	Paragraphs 1.1, 3.46, 5.5, 6.3.1, 9.5, 11.3.2.4, 12.1.3, 12.2.4, 14.4, 21.1, 22.4.1 – 22.4.3, 23.2.1 – 23.2.7, 23.3.1, 23.3.2, 33.1.2, 33.1.3, 33.2.2 – 33.2.4, 33.3.2, 33.3.4 (a) and (d), 33.3.7, 33.5.1, 34.1.3 – 34.1.5, 34.2.1.1, 34.2.2.1, 34.3.4 – 34.3.7, 36.1.2, 36.1.8 – 36.1.11, 36.2.3 – 36.2.8(a), 36.2.10, 36.3.1, 36.3.5, 36.3.7, 36.4.2, 38.1.2, 38.1.3, 38.3.1, 38.4.1 – 38.4.3, 38.5.2, 38.5.4, 38.5.5, 39.2.10, 39.2.11, 39.3.2, 39.3.4, 40.1.2 – 40.1.6, 40.2.7, 40.3.2.8 – 40.3.2.14, 40.3.4.1, 40.3.5.1 – 40.3.5.5, 40.3.6.1, 40.3.6.2, 40.4.1 – 40.4.7, 40.5.1 – 40.5.12, 40.7.1, 42.1.2, 42.1.3, 42.3.3, 42.3.4, 45.1.2, 45.2.2, 45.3.2(a), 45.3.3, 45.4.1, 47.1, 48.6, 49.2, 49.3, 50.1.1, 50.1.4, 50.2.1 – 50.2.4, 50.3.1 – 50.3.5, 51.1.3, 51.1.4, 51.2.1, 51.3.1 – 51.3.3, 51.4.1 – 51.4.3, 51.5.5, 51.5.7, 51.5.10, 51.5.11, 51.5.12, 51.6.1 – 51.6.5, 52.5(a), 52.6, 53.2, Exception No. 2 of 53.5, 53.7, 55.2.1, 55.2.6, 55.3.1, 55.3.2, 55.4.1 – 55.4.3, 55.5.1 – 55.5.3, 55.6.1 – 55.6.4, 55.7.1, 55.7.2, 61.2.1.1, 61.2.2.1 – 61.2.2.5, 61.2.3.1 – 61.2.3.4, 61.4.1, 61.4.2, 61.5.1.1, 61.5.1.2, 61.5.2.1 – 61.5.2.3, 61.5.3.1 – 61.5.3.6, 61.5.4.1 – 61.5.4.4, 61.5.5.1, 61.5.5.2, 62.15, 63.2.4, 63.2.5, 65.3.5, 71.1.1, 71.1.2, 71.3.1, 75.4.1 – 75.4.4, 89.1.1, 89.1.4, 89.1.7, 89.1.9, 89.1.11, 89.1.13, 90.4, 90.6, 90.7, 90.10, 90.23; Sections 26 – 29, 44, 46, 54, 56 – 59, 64, 78 – 86; Tables 51.1 – 51.3, 61.1 – 61.5; and Figure 49.1

The revisions dated May 29, 2007 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

UL's Standards for Safety are copyrighted by UL. Neither a printed copy of a Standard, nor the distribution diskette for a Standard-on-Diskette and the file for the Standard on the distribution diskette should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL provides this Standard ″as is″ without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

UL will attempt to answer support requests concerning electronic versions of its Standards. However, this support service is offered on a reasonable efforts basis only, and UL may not be able to resolve every support request. UL supports the electronic versions of its Standards only if they are used under the conditions and operating systems for which it is intended. UL's support policies may change from time-to-time without notification.

UL reserves the right to change the format, presentation, file types and formats, delivery methods and formats, and the like of both its printed and electronic Standards without prior notice.

Purchasers of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgement (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

If a single-user version electronic Standard was purchased, one copy of this Standard may be stored on the hard disk of a single personal computer, or on a single LAN file-server or the permanent storage device of a multiple-user computer in such a manner that this Standard may only be accessed by one user at a time and for which there is no possibility of multiple concurrent access.

If a multiple-user version electronic Standard was purchased, one copy of the Standard may be stored on a single LAN file-server, or on the permanent storage device of a multiple-user computer, or on an Intranet server. The number of concurrent users shall not exceed the number of users authorized.

Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

Copyright © 2007 Underwriters Laboratories Inc.

This Standard consists of pages dated as shown in the following checklist:

No Text on This Page

SEPTEMBER 30, 2003
(Title Page Reprinted: May 29, 2007)

UL 864

Standard for Control Units and Accessories for Fire Alarm Systems

The First through Eighth Editions of this standard were titled Control Units for Fire-Protective Signaling Systems.

First Edition – October, 1948
Second Edition – September, 1957
Third Edition – February, 1972
Fourth Edition – September, 1972
Fifth Edition – January, 1975
Sixth Edition – June, 1980
Seventh Edition – May, 1991
Eight Edition – November, 1996

Ninth Edition

September 30, 2003

The most recent designation of ANSI/UL 864 as an American National Standard (ANSI) occurred on March 30, 2006. The ANSI approval for this standard does not include the Cover Page, transmittal pages, or Title Page.

This ANSI/UL Standard for Safety, which consists of the Ninth Edition with revisions through May 29, 2007 is under continuous maintenance, whereby each revision is ANSI approved upon publication.

The Department of Defense (DoD) has adopted UL 864 on May 2, 1991. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI standard.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. 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 http://csds.ul.com.

ISBN 0-7629-0795-9

COPYRIGHT © 1975, 2007 UNDERWRITERS LABORATORIES INC.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

PROTECTION AGAINST INJURY TO PERSONS

PERFORMANCE

GENERAL

OPERATION TESTS

LOCAL SERVICE

RELEASING SERVICE

REMOTE STATION, CENTRAL STATION, AND PROPRIETARY SERVICES

AUXILIARY SERVICE

MARINE APPLICATIONS

SMOKE-CONTROL APPLICATIONS

COMMON REQUIREMENTS

OTHER TESTS

MANUFACTURING AND PRODUCTION-LINE TESTS

MARKINGS AND INSTRUCTIONS

APPENDIX A

This page intentionally left blank.

INTRODUCTION

1 Scope

1.1 These requirements cover discrete electrical control units and accessories for fire alarm systems to be employed in accordance with the following National Fire Protection Association (NFPA) Standards:

a) NFPA 12, Carbon Dioxide Extinguishing Systems;

b) NFPA 12A, Halon 1301 Fire Extinguishing Systems;

c) NFPA 13, Installation of Sprinkler Systems;

d) NFPA 15, Water Spray Fixed Systems for Fire Protection;

e) NFPA 16, Installation of Foam-Water Sprinkler and Foam-Water Spray Systems;

f) NFPA 17, Dry Chemical Extinguishing Systems;

g) NFPA 17A, Wet Chemical Extinguishing Systems;

h) NFPA 70, National Electrical Code;

i) NFPA 72, National Fire Alarm Code;

j) NFPA 92A, Recommended Practice for Smoke-Control Systems;

k) NFPA 92B, Guide for Smoke Management Systems in Malls, Atria, and Large Areas;

l) NFPA 2001, Clean Agent Fire Extinguishing Systems.

1.1 effective December 31, 2008

1.2 The products covered by this standard are intended to be used in combination with other appliances and devices to form a commercial fire alarm system. These products provide all monitoring, control, and indicating functions of the system. An installation document(s) provided with the product describes the various products needed to form a fire alarm system and their intended use and installation.

1.3 These requirements do not cover manual boxes, automatic fire detectors, automatic transmitters, or other initiating devices; nor do they cover notification appliances not provided as part of the product.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, 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 used in the products covered by this standard.

2.1.2 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.

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

2.1.4 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.

2.2 Units of measurement

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

2.3 Undated references

2.3.1 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.

3 Glossary

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

3.2 ACKNOWLEDGE – Action taken to confirm that a message or signal has been received, such as pressing a button.

3.3 ACTIVE MULTIPLEX SYSTEM – A system employing a signaling method characterized by simultaneous or sequential transmission, or both, and reception of multiple signals, including a means for positively identifying each signal. Employs signaling devices such as transponders and transceivers to transmit status signals of each initiating device within a prescribed time interval so that lack of receipt of such signal is to be interpreted as a trouble signal.

3.4 ADDRESSABLE DEVICE – A fire alarm system component with discrete identification that can have its status individually identified or that is used to individually control other functions.

3.5 ADVERSE CONDITION – Any condition occurring in a circuit or communication path that interferes with the proper signaling or interpretation of status-change signals or both. Conditions include radio frequency interference.

3.6 AIR-HANDLING SPACE – Space used for environmental air-handling purposes other than ducts or plenums. The space over a hung ceiling used for environmental air-handling is an example.

3.7 ALARM SIGNAL – A signal indicating an emergency condition requiring immediate action such as a signal indicative of a fire.

3.8 ALARM VERIFICATION – A feature of automatic fire-detection and alarm systems to reduce unwanted alarms wherein smoke detectors report alarm conditions for a minimum period of time, or confirm alarm conditions for a given period of time after reset, in order to be accepted as a valid alarm initiation.

3.9 ALERT TONE – An attention-getting signal to alert occupants of the pending transmission of a voice message.

3.10 ANALOG INITIATING DEVICE (SENSOR) – An initiating device that transmits a signal indicating varying degrees of conditions as contrasted with a conventional device, which can only indicate an alarm/no alarm condition.

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

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

3.13 CIRCUIT CLASSIFICATIONS:

a) High-Voltage Circuit – A circuit involving a potential of not more than 300 volts nominal and having characteristics in excess of those of a low-voltage circuit.

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

c) Power-Limited Circuit – A circuit wherein the power is limited as specified in Tables 60.1 and 60.2.

3.14 CODED SIGNAL – Signal pulsed in a prescribed code for each round of transmission which conveys information on the location from which the status-change signal originated. A minimum of three rounds is required for an alarm signal.

3.15 COMBINATION SYSTEM – A fire alarm system whose components might be used, in whole or in part, in common with a non-fire alarm signaling system such as smoke control, security, process monitoring, paging, or building automation.

3.16 COMMUNICATION(S) CIRCUIT – A circuit or path connecting subsidiary/satellite station(s) to supervising station(s) over which signals are carried.

3.17 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.

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

3.19 CONTROL UNIT, PROTECTED PREMISES – 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 required by the system type.

3.20 CONTROL UNIT, SUPERVISING STATION – A unit that directly or indirectly receives status-change signals from one or more protected-premises control units and performs processing and logical control to generate output signals required by the system type.

3.21 CONTROL UNIT SYSTEM TYPES:

a) Auxiliary – A system that uses the municipal fire alarm system for transmitting an alarm of fire to the public fire service communications center. Fire-alarm signals transmitted from the premises are received at the public fire service communications center on the same equipment and by the same method as alarms transmitted manually from the fire alarm boxes located on the street.

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

c) Local – A system located at the protected premises which indicates alarm, trouble and supervisory conditions via notification appliances within the protected premises.

d) Marine – A local protected premises system that is intended to be installed aboard a commercial vessel.

e) Proprietary – Local control unit installed at the protected premises with provision for connection via a transmission channel to a Proprietary Receiving Unit. A system in which status change signals occurring at the protected premises are automatically transmitted to an on-premises supervising 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 one ownership.

f) Releasing – A local protected premises system that also initiates release of an extinguishing agent upon the detection of an alarm condition.

g) Remote Station – A system in which status change signals occurring at a protected premises are transmitted to a supervising station at a public fire services communications center, a fire station, or a similar governmental agency that has a public responsibility for taking prescribed action to ensure response upon receipt of a fire alarm signal. Trouble and supervisory signals may be transmitted to a supervising station at a different location.

h) Smoke Control – A system which, during an alarm condition, provides selective and overriding control of mechanical fans, dampers, and the like to produce airflow and pressure differences across smoke barriers to limit and direct smoke movement. A system is categorized as either or both of the following types:

Dedicated – A system which is normally inactive and is used exclusively for the purpose of smoke control.

Nondedicated – A system which provides the building heating-ventilating-air conditioning (HVAC) function under normal conditions and provides a smoke control objective during a fire alarm condition.

3.22 CONVENTIONAL DEVICE – An initiating device or notification appliance that cannot be individually identified or selected for control by the fire alarm system.

3.23 DELINQUENCY SIGNAL – A signal indicating the need for action in connection with a guard tour.

3.24 DERIVED CHANNEL – A circuit that uses the local leg of the public switched network as an active multiplex channel while simultaneously allowing that leg's use for normal telephone communications.

3.25 DIGITAL ALARM COMMUNICATOR RECEIVER (DACR) – A system component that accepts and displays signals from digital alarm communicator transmitters (DACTs) sent over the public switched telephone network.

3.26 DIGITAL ALARM COMMUNICATOR SYSTEM (DACS) – A system in which signals are transmitted from a digital alarm communicator transmitter (DACT), located remote from the supervising station, through the public-switched telephone network to a digital alarm communicator receiver (DACR).

3.27 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT) – A system component to which initiating devices or groups of devices are connected. The DACT seizes the connected telephone line, dials a pre-selected number to connect to a DACR, and transmits signals indicating a status change.

3.28 DIGITAL ALARM RADIO RECEIVER (DARR) – A system component that receives and decodes radio signals.

3.29 DIGITAL ALARM RADIO SYSTEM (DARS) – A system in which signals are transmitted from a digital alarm radio transmitter (DART) located remote from the supervising station through a radio channel to a digital alarm radio receiver (DARR).

3.30 DIGITAL ALARM RADIO TRANSMITTER (DART) – A system component to which initiating devices or a group of devices are connected.

3.31 DISPLAY – The visual representation of output data or status information, other than printed copy.

3.32 DISTINCTIVE SIGNALS – Signals obtained from different sounding appliances (such as bells, horns, sirens, and buzzers) or from a single appliance (such as an electronic horn) where a continuous signal is obtained under one condition and a pulsing signal under another.

3.33 EMERGENCY VOICE/ALARM COMMUNICATIONS – Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to a fire emergency, to the occupants of a building.

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

3.35 EVACUATION – The withdrawal of occupants from a building.

3.36 EVACUATION SIGNAL – Distinctive signal intended to be recognized by the occupants as requiring evacuation of the building.

3.37 EXTERNAL CIRCUITS – Circuits or wiring leaving the product.

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

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

3.40 FIRE COMMAND CENTER – The principal attended or unattended location where the status of the detection, alarm communications, and control systems is displayed and from which the system can be manually controlled.

3.41 FIREFIGHTER'S SMOKE CONTROL STATION (FSCS) – A product that includes monitoring and overriding control capability over smoke control systems and equipment for the use of the fire department.

3.42 FIRE SAFETY FUNCTION – Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire.

3.43 FIXED EQUIPMENT – Any equipment product that is intended to be permanently connected electrically to the wiring system.

3.44 GATEWAY – A device that is used in the transmission of digital or analog data from the fire alarm control unit to other building-systems control units, equipment, or networks, and/or from other building-system control units to the fire alarm system.

3.45 GROUNDED CONDUCTOR – A conductor employed to connect the intentionally grounded circuit of a wiring system to a grounding electrode.

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

3.46 effective December 31, 2008

3.47 GROUNDING CONDUCTOR – A conductor employed to connect non-current-carrying parts of equipment, raceways, and enclosure to a grounding electrode at the service which is, in turn, connected to earth ground or to some conducting body which serves in place of earth ground.

3.48 GUARD TOUR SUPERVISORY SERVICE SIGNAL – A supervisory signal monitoring the performance of guard patrols.

3.49 INITIATING DEVICE – A manually- or automatically-operated device, the normal intended operation of which results in a fire alarm or supervisory signal indication from the control unit. Examples of alarm-initiating devices are thermostats, manual boxes, smoke detectors, water-flow switches, and proof sensors. Examples of supervisory signal-initiating devices are water-level indicators, sprinkler-system valve-position signals, pressure supervisory transmitters, and water-temperature switches.

3.50 INITIATING DEVICE CIRCUIT – Circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated.

3.51 INSTALLATION LOCATIONS:

a) Damp – A location protected from sun, rain, and water, but may be subject to moisture. Such locations may include basements, barns, cold-storage warehouses, greenhouses, indoor swimming facilities, and the like. They may also include partially protected locations under canopies, marquees, roofed open porches, and the like.

b) Dry – A location with a controlled ambient that is not subject to dampness or wetness.

c) Wet – A location subject to rain (or the spray of noncorrosive and nonflammable liquids) that may become saturated with water or that is unprotected from the weather.

3.52 INTERCOM – Two-way voice-communication equipment intended for fire-emergency use.

3.53 KEYPAD – A means of manually controlling the product. Provided with a visual-indicating device containing identified targets or indicator lamps, alphanumeric displays, or other equivalent means, in which each indication provides status information about a circuit, condition, and/or location.

3.54 LEG FACILITY – That part of the communication channel that connects each protected building or premises to the trunk facility.

3.55 LIFE SAFETY NETWORK – A combination system that carries other signals in addition to fire alarm signals and is connected to a fire alarm system.

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

3.57 MULTIPLEXING – A signaling method using wire path, cable carrier, radio, or combinations of these facilities 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.

3.58 NONCODED SIGNAL – Signal from a notification appliance that does not give information on the location of the initiating device which is in the alarm condition.

3.59 NON-VOLATILE MEMORY – A storage device not alterable by the interruption of the power to the memory; for example, ROM, FLASH, PROM, EPROM, and EEPROM.

3.60 NOTIFICATION APPLIANCE – Any audible, tactile, or visual signal or any combination thereof employed to indicate a fire, supervisory, or trouble condition.

3.61 NOTIFICATION APPLIANCE CIRCUIT – A circuit or path directly connected to a notification appliance.

3.62 NOTIFICATION ZONE – An area covered by notification appliances that are activated simultaneously.

3.63 OFF-HOOK – To make connection with the public-switched telephone network in preparing to dial a telephone number.

3.64 ON-HOOK – To disconnect from the public switched telephone network.

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

3.66 OPERATOR – Individual(s) responsible to access and operate the product and/or system.

3.67 OPERATOR INTERFACE – Providing controls for manually operating the product/system.

3.68 PATH – Any conductor, optic fiber, radio carrier, or other means for transmitting information between two or more units and/or locations.

3.69 POLARITY REVERSAL CIRCUIT – Direct-current circuit employed where an alarm condition results in a polarity reversal on a communications or transmission line.

3.70 PORTABLE EQUIPMENT – A product that is easily carried or conveyed by hand. When intended to be connected to a high-voltage circuit, the product is provided with a power supply cord for connection to the supply circuit.

3.71 POSITIVE ALARM SEQUENCE – An automatic sequence that results in an alarm signal, even when manually delayed for investigation, unless the system is reset.

3.72 POWER SUPPLY – A source of electrical operating power including the circuits and terminations connecting it to the dependent product/system components.

3.73 PRERECORDED MESSAGE DEVICE – An automatically- or manually-actuated device intended to translate a pre-recorded message stored on a tape or other medium into an electronic signal that when amplified and introduced into speakers produces vocal or tonal information.

3.74 PRE-SIGNAL ALARM – An arrangement where the operation of an automatic detector or initial operation of a manual station actuates only a selected indicating-device or devices for the purpose of notifying key personnel who then have the option of initiating a general alarm.

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

3.76 PRIMARY OPERATOR INTERFACE – Intended to be the main means of interfacing the controls for manually operating the product/system.

3.77 PRIVATE-RADIO FREQUENCY SYSTEM – A radio system under the control of the supervising station or other company where only private access to the system is permitted.

3.78 PROTECTED PREMISES – The physical location protected by a fire alarm system.

3.79 RESET – A control function that attempts to return a system or device to its normal non-alarm state.

3.80 RISK OF ELECTRIC SHOCK – A risk of electric shock is determined to exist within a circuit unless that circuit meets one of the following criteria:

a) 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, or

b) 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 5 mA.

3.81 RISK OF FIRE – A risk of fire is determined to exist within a circuit unless that circuit meets both of the following criteria:

a) The circuit is supplied by a power source such that the maximum open-circuit voltage potential available to the circuit is not more than 30 V AC or 42.4 V DC or peak and

b) The circuit in which the power available to the circuit is limited to a value less than 15 watts.

3.82 SATELLITE/SUBSIDIARY STATION – A normally unattended location capable of being manned, but removed from the supervising station and linked to the supervising station by communication channel(s). This location interconnects signal-receiving equipment or communications channel(s) from protected buildings or premises to the supervising station.

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

3.84 SIGNALING-LINE CIRCUIT – A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple-system input signals or output signals, or both, are carried.

3.85 SIGNALING-LINE CIRCUIT INTERFACE – A system component that connects a signaling-line circuit to any combination of initiating devices, initiating-device circuits, notification appliances, notification appliance circuits, system control outputs, and other signaling-line circuits.

3.86 SOFTWARE – Programs, instructions, procedures, data, and the like that are executed by a central processing unit of a product and which influences the functional performance of that product. For the purpose of this standard, software is one of two types:

a) Executive Software – Control and supervisory program which manages the execution of all other programs and directly or indirectly causes the required functions of the product to be performed.

b) Site-Specific Software – Program that is separate from, but controlled by, the executive software which allows inputs, outputs, and system configuration to be selectively defined to meet the needs of a specific installation.

3.87 STANDBY POWER SOURCE – Provides power when the primary power source fails.

3.88 STATIONARY EQUIPMENT – Any product that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

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

3.90 SUPERVISING STATION – A facility that receives signals and at which personnel are in attendance at all times to respond to these signals.

3.91 SUPERVISORY SIGNAL – A signal indicating the need of action in connection with the supervision of watchmen, sprinkler and other extinguishing systems or equipment, or with the maintenance features of other protective systems.

3.92 SUPPLEMENTARY – Refers to equipment or operations not required by this standard.

3.93 SUPPLEMENTARY DEVICE – A device intended to be connected to a supplementary device circuit.

3.94 SUPPLEMENTARY-DEVICE CIRCUIT – A circuit provided by a product for controlling a device, the operation of which is supplementary to the primary initiating and indicating devices of the control unit.

3.95 SWITCHED-TELEPHONE NETWORK – An assembly of communications facilities and central-office equipment operated jointly by authorized service providers that provides the general public with the ability to establish transmission channels via discrete dialing.

3.96 TONE GENERATOR – A device intended to generate an electronic signal that, when amplified and introduced into speakers, produces a non-prerecorded, non-vocal, audible signal recognizable as indicating an evacuation condition.

3.97 TRANSMISSION FAULT – Any condition which interrupts communication between protected premises and the supervising station.

3.98 TRANSMISSION LINE – A circuit or path connecting transmitters to supervising stations or subsidiary/satellite station(s) over which signals are carried.

3.99 TRANSMITTER – A system component that provides an interface between a protected premises unit and the transmission channel.

3.100 TRANSPONDER – A multiplex alarm transmission system functional assembly located remote from the supervising station.

3.101 TROUBLE SIGNAL – A visual or audible signal indicating a fault condition of any nature, such as a circuit break or ground or other trouble condition occurring in the device or wiring associated with a protective signaling system.

3.102 TRUNK FACILITY – That part of the communications channel that connects two or more leg facilities to a central supervising or satellite station.

a) Primary Trunk Facility – That part of a communication channel that connects all leg facilities to a central supervising or satellite station.

b) Secondary Trunk Facility – That part of a communication channel that connects two or more, but not all, leg facilities to a primary trunk facility.

3.103 USER – An individual who operates or services the product.

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

3.105 ZONE – A defined area within the protected premises. A zone defines an area from which a status indication can be received or an area in which a form of control can be executed.

4 Information Required for Assessment

4.1 The following documentation may be required to determine compliance:

a) Schematic diagrams of all circuits.

b) Where the product uses software, evidence of software integrity as described in 54.3.1 – 54.3.4.

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

d) Installation wiring diagram/instructions as required in Installation Wiring Diagram/Instructions, Section 90.

e) Operating instructions as required in Operating Instructions, Section 91.

CONSTRUCTION

5 General

5.1 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.

5.2 Metals, when required to meet the requirements of this standard, shall not be used in such combination as to cause galvanic action that will increase the risk of fire, electric shock, injury to persons, or impair the operation of a product associated with the safety of life and/or property protection.

5.3 Where breakage or deterioration of a part such as an enclosure, a frame, a guard, or the like can result in a risk of injury to persons, the part shall be constructed to meet the demand or expected loading conditions.

5.4 The requirement in 5.3 applies also to those positions of a part adjacent to a moving part identified to involve a risk of injury to persons.

5.4 revised July 14, 2005

5.5 Products intended to be installed in air-handling spaces shall comply with the requirements in the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043.

5.5 effective December 31, 2008

6 Enclosures

6.1 General

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

6.2 Metallic material

6.2.1 An enclosure of metal shall have a minimum thickness as specified in Tables 6.1, 6.2, or 6.3, or shall comply with the test requirements in Mechanical Strength Tests for Metal Enclosures and Guards, Section 77.

Table 6.1
Cast-metal electrical enclosures

Use, or dimensions of area involved[a]	Minimum thickness			
	Die-cast metal,		Cast metal other than die-cast,	
	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) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

Table 6.2
Minimum thickness of sheet metal for electrical enclosures of carbon or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Uncoated,		Metal coated,	
inches	(cm)	inches	(cm)	inches	(cm)	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]		

Table 6.2 Continued on Next Page

Table 6.2 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length, inches	(cm)	Uncoated, inches [MSG]	(mm)	Metal coated, inches [GSG]	(mm)
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 that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that 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 that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

1) A single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or r bbed, 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.

Table 6.3
Minimum thickness of sheet metal for electrical enclosures of aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length, inches	(cm)	inches	(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			

Table 6.3 Continued on Next Page

Table 6.3 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]					
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length, inches	(cm)	Minimum thickness, inches	(mm)
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) A single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or r bbed, 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.

6.2.2 Where threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or where a construction that is determined to be equivalent is used, there shall not be less than 3-1/2 nor more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing can be attached.

6.2.3 Where 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 five full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

6.2.4 At any point where conduit or metal-clad cable is to be attached to the enclosure, sheet metal shall be of such thickness or shall be so formed or reinforced that it will have stiffness at least equivalent to that of an uncoated flat sheet of steel having a minimum thickness of 0.032 inch (0.81 mm).

6.3 Polymeric materials

6.3.1 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.

6.3.1 effective December 31, 2008

6.3.2 Polymeric material that is not used as an enclosure, but that is attached to or exposed on the outside of a product such as a viewing window, shall have flammability characteristics as shown in Table 6.4.

Table 6.4
Flammability characteristics of polymeric material

Polymeric material area/dimensions	Flammability rating
0.24 inches^3(4 cm^3) maximum and 2.4 inches (61 mm) maximum length	None
Greater than 0.24 inches^3(4 cm^3) and less than 2 square feet (0.19 m^2), 6 feet (1.83 m) maximum length	HB, V-2, V-1, V-0, or 5V
Greater than 2 square feet (0.19 m^2) and less than 10 square feet (0.93 m^2), 6 feet (1.83 m) maximum length	V-1, V-0, or 5V
Greater than 10 square feet (0.93 m^2), or longer than 6 feet (1.83 m)	Maximum flame spread rating of 200 as specified in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or radiant panel as specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94

6.3.3 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.

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

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

6.4 Covers

6.4.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached to provide access to fuses or any other over current-protective device, the intended protective functioning of which requires renewal or resetting, or when it is necessary to open the cover in connection with the normal operation of the unit.

Exception: In lieu of providing a hinged, sliding, or pivoted cover, supervision of the enclosure cover by means of a tamper feature is suitable when its operation results in either a trouble or alarm signal. This applies only when the cover provides access to overcurrent devices such as fuses or circuit breakers or other indicators that are not used on a continuing basis.

6.4.2 Normal operation referenced in 6.4.1 is determined to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit which requires such action in connection with its intended performance.

6.4.3 A hinged cover is not required when the only fuse(s) enclosed is intended to provide protection to portions of internal circuits used on a separate printed-wiring board or circuit subassembly, to prevent circuit damage resulting from a fault. The use of such a fuse(s) is suitable when the following (or other wording that has been determined to be equivalent) is indicated as a marking on the outside of the cover: ″Circuit Fuse(s) Inside – Disconnect Power Prior To Servicing.″

6.4.4 Glass covering an observation opening shall be tempered and secured in place so that it cannot be displaced and shall provide mechanical protection for the enclosed parts. The thickness of a glass cover shall not be less than that indicated in Table 6.5.

Table 6.5
Thickness of glass covers

Maximum size of opening				Minimum thickness,	
Length or width,		Area,			
inches	(mm)	inches^2	(cm^2)	inch	(mm)
4	102	16	103	1/16	1.6
12	305	144	929	1/8	3.2
over 12	over 305	over 144	over 929	see note a	

[a] 1/8 inch (3.2 mm) or more, depending upon the size, shape, and mounting of the glass panel.

6.4.5 A glass panel for an opening having an area of more than 144 square inches (929 cm^2), or having any dimension greater than 12 inches (305 mm), shall be supported by a continuous groove not less than 3/16 inch (4.8 mm) deep along all four edges of the panel, or other means that have been determined to be an equivalent arrangement.

6.4.6 A transparent material other than glass used for the cover of an observation opening shall not introduce a risk of fire, distort, nor become less transparent at the temperature to which it is intended to be subjected under either normal or abnormal service conditions. See 6.3.2.

6.5 Battery compartments

6.5.1 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.

6.5.2 The interior of a storage battery compartment shall be protected so that it will be resistant to detrimental action by the electrolyte.

6.6 Enclosure openings – general

6.6.1 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: Products supplied solely from power-limited sources and controlling only power-limited loads.

6.6.2 The requirement in 6.6.1 does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) when:

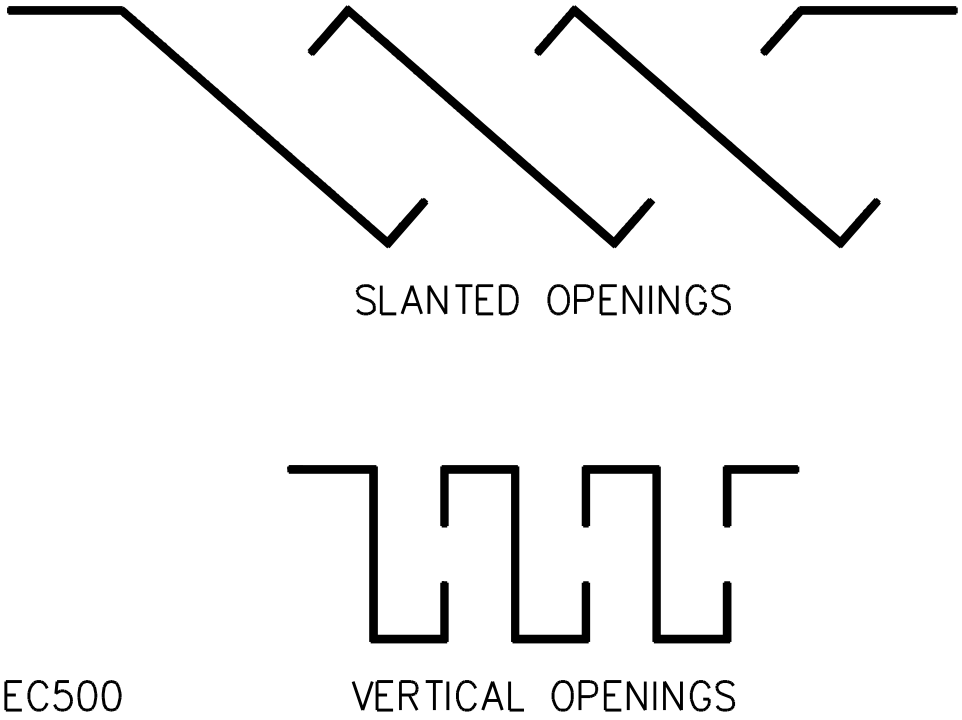
a) An opening for non-mounting purposes does not have a dimension greater than 17/64 inch (6.75 mm) or an area greater than 0.055 square inch (35.5 mm^2) and

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

6.7 Enclosure top openings

6.7.1 An opening directly over an uninsulated live part involving a risk of fire, electric shock, or electrical-energy/high-current levels, 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. See Figure 6.1 for examples of top-cover designs complying with the intent of the requirement.

Figure 6.1
Cross-sections of top-cover designs



6.8 Enclosure side openings

6.8.1 An opening in the side of the enclosure shall:

a) Not exceed 0.19 inch (4.8 mm) in any dimension;

b) Be provided with louvers shaped to deflect an external falling object outward (see Figure 6.2 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 6.3).

Figure 6.2
Louvers

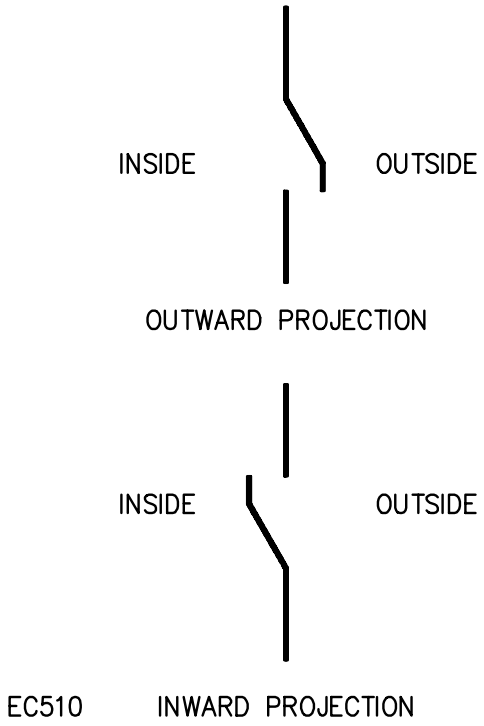
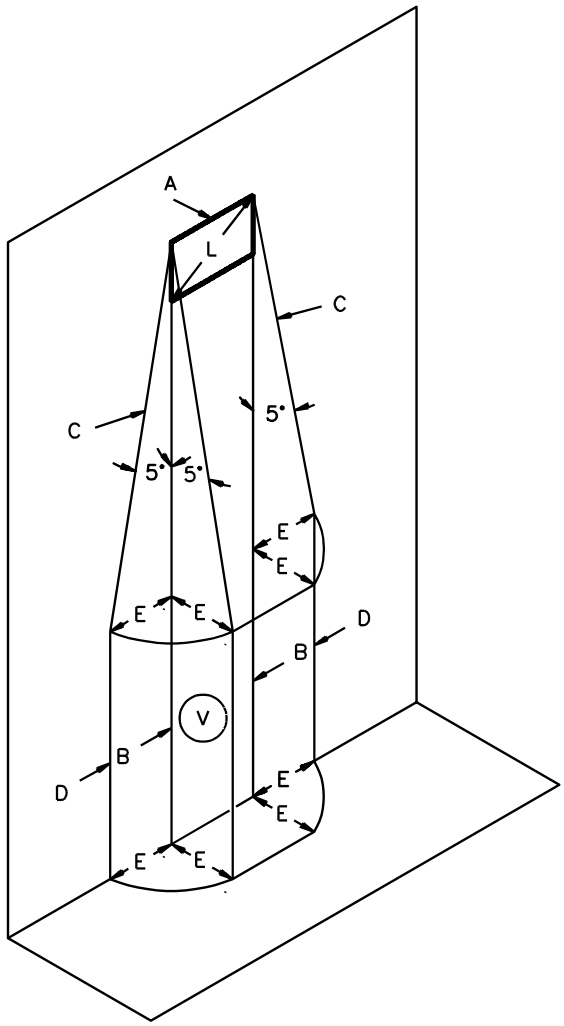


Figure 6.3
Example of enclosure side opening



S3162A

A – Enclosure side opening.

B – Vertical projection of the outer edges of the side opening.

C – Inclined lines that project at a 5-degree angle from the edges of the side opening to point located E distance from B.

D – Line which is projected straight downward in the same plane as the enclosure side wall.

E – Projection of the opening (not to be greater than L).

L – Maximum dimension of the enclosure side opening.

V – Volume in which bare parts at uninsulated live parts are not located.

6.8.2 When a portion of a side panel falls within the area traced out by the 5-degree angle in Figure 6.4, that portion of the side panel shall be investigated as a bottom enclosure in accordance with 6.9.1 – 6.9.3.

6.9 Enclosure bottom openings

6.9.1 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 6.4, that complies with the ventilation opening requirements in 6.9.2 and 6.9.3 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.

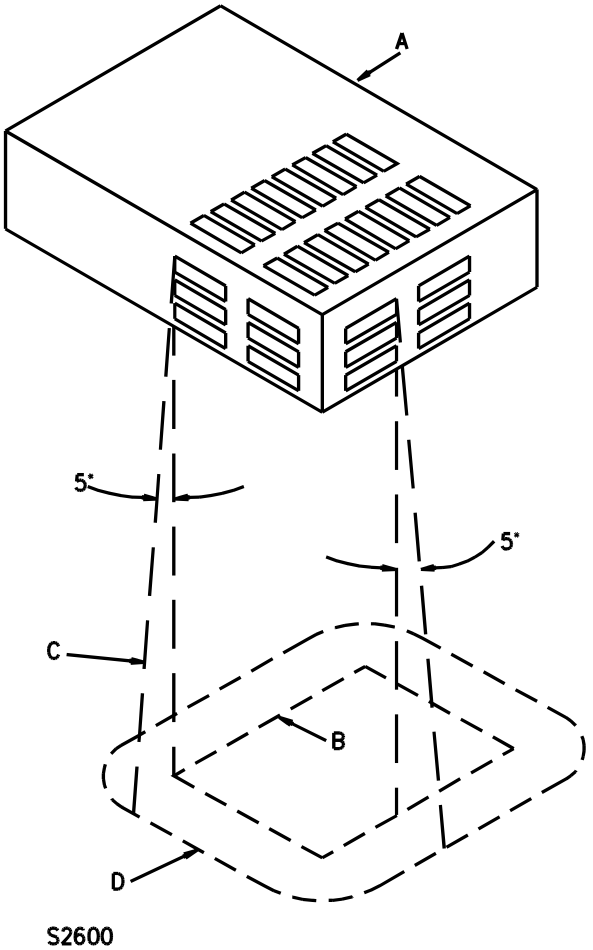
6.9.2 Ventilation openings provided in the bottom of an enclosure under materials that are not rated V-1 or less flammable meet the intent of the requirements when the openings are constructed so that materials do not fall directly from the interior of the unit. Other bottom-opening constructions that comply with the intent of the requirements are those that incorporate a perforated metal plate as described in Table 6.6, 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, Section 73.

Table 6.6
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	0.67 [233 holes per inch^2]	1.70 [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 [72 holes per inch^2]	3.18 [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

6.9.3 The bottom of the enclosure under areas containing only materials rated V-1 or less flammable shall have openings no larger than 1/16 inch^2 (40 mm^2).

Figure 6.4
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 degree 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 degrees 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.

7 Internal Materials

7.1 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.

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

Exception: 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 foamed 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.

8 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

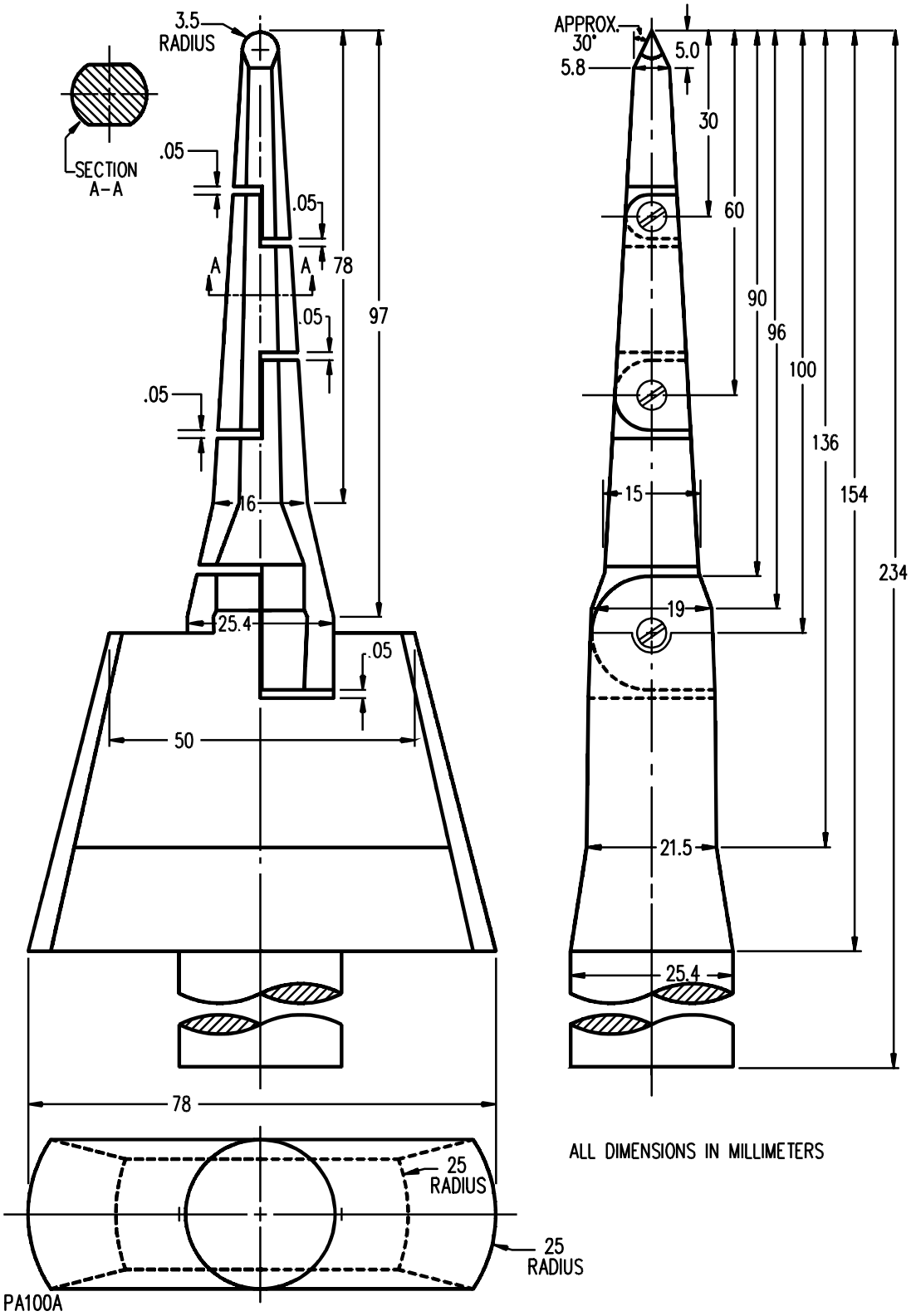
8.1 To reduce the risk of unintentional contact and electric shock from an uninsulated live part or film-coated wire, and injury to persons from a moving part, an opening in an enclosure shall have a minor dimension less than 1 inch (25.4 mm), and such a part or wire shall not be contacted by the probe illustrated in Figure 8.1.

8.2 The probe illustrated in Figure 8.1 shall be applied to any depth that the opening will permit. The probe shall be rotated or angled before, during, and after insertion through the opening to any position that is required in order to examine the enclosure. The probe illustrated in Figure 8.1 shall be applied in any possible configuration and, when necessary, the configuration shall be changed after insertion through the opening.

8.3 The probe illustrated in Figure 8.1 shall be used as a measuring instrument to evaluate the accessibility provided by an opening, and not as an instrument to evaluate the strength of a material. It shall be applied with the minimum force required to determine accessibility.

8.4 During the examination of a product to determine whether it complies with the requirement in 8.1, a part of the enclosure that is to be opened or removed by the operator without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) shall be opened or removed.

Figure 8.1
Articulate probe with web stop



9 Mechanical Assembly

9.1 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.

9.2 A switch, fuseholder, lampholder, attachment-plug receptacle, motor-attachment plug, or other similar component shall be mounted securely and shall not turn.

Exception No. 1: When the turning of a switch is possible, all four of the following conditions shall be met:

a) The switch shall be of a plunger, slide, or other type that does not tend to rotate when operated. A toggle switch is determined 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 operation of the switch loosens it;

c) The spacings are not reduced below the minimum required values when the switch rotates; and

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

Exception No. 2: When rotation does not reduce spacings below the minimum required value, 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, complies with the intent of the requirement.

9.3 Friction between surfaces shall not be used for securing the position of the parts specified in 9.2.

9.4 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.

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

9.5 effective December 31, 2008

10 Protection Against Corrosion

10.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other means that have been determined to be equivalent, when corrosion of unprotected parts results in a risk of fire, electric shock, injury to persons, or impairment of operation of a product.

Exception No. 1: Surfaces of sheet-steel and cast-iron parts within an enclosure are not required to be protected against corrosion when oxidation of the metal due to exposure to air and moisture is not likely to weaken the parts to result in a condition of risk. The thickness of metal and temperature are also to be evaluated.

Exception No. 2: Bearings, laminations, or minor parts or iron or steel, such as washers, screws, and similar equipment, are not required to be protected against corrosion.

11 Branch-Circuit Connection

11.1 General

11.1.1 Control units and accessories shall be provided with a means for permanent connection to the branch-circuit supply.

Exception: Video display terminals, other operator interface products, and printers installed within a supervising station that may be repositioned for normal use or maintenance.

11.2 Permanently connected

11.2.1 General

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

Exception: An enclosure without provisions for connection to rigid metallic conduit is acceptable when the installation instructions specifically indicate which sections of the enclosure may be drilled for the connection.

11.2.1.2 A knockout or other supply-connection opening located where temperatures in excess of 140°F (60°C) have been measured during the Component Temperature Test, Section 62, and not having qualifying marking as specified in 89.1.8, shall be sealed by welding or the equivalent or be permanently marked adjacent to the opening with: ″Do Not Use″.

11.2.2 Field-wiring compartment

11.2.2.1 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.

11.2.2.2 A terminal compartment intended for connection of a supply raceway shall be attached to the product so that it does not turn.

11.2.2.3 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.

11.2.2.4 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: “CAUTION – When Making Installation, Route Field Wiring Away From Sharp Projections, Corners, and Internal Components”.

11.2.2.5 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.

11.2.3 Field-wiring terminals and leads

11.2.3.1 A permanently connected product shall be provided with wiring terminals or leads for the connection of conductors having an ampacity not less than 125 percent of the current input of the product when connected to a power-supply voltage in accordance with 30.1.1 – 30.1.5.

11.2.3.2 The free length of a lead inside a terminal box or compartment shall be 6 inches (150 mm) or more, provided with strain relief, shall not be smaller than 18 AWG (0.82 mm^2), and the insulation, when of rubber or thermoplastic, shall not be less than 1/32 inch (0.8 mm) when the lead is intended for field connection to an external circuit.

Exception: The lead shall be less than 6 inches (150 mm) long when it is evident that the use of a longer lead results in a risk of fire or electric shock

11.2.3.3 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.

11.2.3.4 A field-wiring terminal shall comply with the requirements in 12.4 for field-wiring terminals (general application) except a wire-binding screw shall not have a diameter smaller than No. 8 (4.2 mm).

11.2.4 Identified terminals and leads

11.2.4.1 A permanently-connected product rated 125 or 125/250 V (3-wire) or less, and using a lampholder of the Edison screw-shell type, or a single-pole switch or overcurrent protective device other than an automatic control without a marked-off position, shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. This terminal or lead shall be electrically connected to screw shells of lampholders and shall not be connected to switches or overcurrent protective devices of the single-pole type other than automatic controls without a marked-off position.

11.2.4.2 A terminal intended for the connection of a grounded supply conductor shall be 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 shown in some other manner, such as on an attached wiring diagram.

11.2.4.3 A lead intended for the connection of a grounded power-supply conductor shall be finished white or gray color and shall be distinguishable from the other leads.

11.2.5 Strain relief

11.2.5.1 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.

11.2.5.2 Each lead used for field connections or an internal lead subjected to movement or handling during installation and servicing shall be capable of withstanding for 1 minute a pull of 10 pounds (4.54 kg) without any evidence of damage or of transmitting the stress to internal connections.

11.3 Cord-connected product

11.3.1 Cords and plugs

11.3.1.1 A product shall be provided with a length of 5 – 15 feet (1.5 – 4.5 m) flexible cord and a grounded attachment plug when intended for connection to a line voltage branch-circuit supply. See Tables 11.1 and 11.2.

Exception No. 1: A length of flexible cord of Type S, or cord determined to be equivalent, not exceeding 25 feet (7.5 m).

Exception No. 2: The length of the power-supply cord on an appliance intended for a special installation, such as dedicated equipment intended to be mounted near a receptacle may be less.

Exception No. 3: A polarized attachment plug, rather than a grounded attachment plug, when the product has no accessible dead-metal parts likely to be energized.

Exception No. 4: An attachment plug is not required to be polarized or grounded when there are no accessible dead-metal parts likely to be energized and no single-pole devices in primary circuits.

Exception No. 5: Double insulated equipment shall not be grounded. Refer to the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

Table 11.1
Grounding, polarization, and double insulation (DI) scheme requirements

Product	Attachment plug
Connected to branch circuit with accessible dead metal	Grounding or insulation scheme of DI
Connected to branch circuit with no accessible dead metal	Grounding, polarization, or insulation scheme of DI
Connected to branch circuit with no accessible dead metal and no single-pole devices in primary circuits	Non-grounding, grounding, polarization, or insulation scheme of DI

Table 11.2
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).

11.3.1.2 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.

11.3.1.3 The flexible cord on a cord-connected unit shall be as indicated in Table 11.2 or shall be of a type at least as serviceable for the particular application. Table 11.3 specifies cord types determined to be equivalent to those specified in Table 11.2.

Table 11.3
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

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

11.3.1.5 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 field alteration of 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.

11.3.1.6 The flexible cord shall be attached permanently to the product and means shall be provided to physically secure the attachment plug or plug-in transformer to the power receptacle so as to prevent accidental removal.

Exception: For monitors and other operator interface products, a detachable power-supply cord without physical securing means is suitable.

11.3.2 Strain relief

11.3.2.1 A power-supply cord shall be provided with strain-relief means to keep tension on the cord from being transmitted to terminals, splices, or wiring within the product. The strain-relief means provided shall comply with the Strain-Relief Test, Section 82.

11.3.2.2 Means shall be provided so that the flexible cord cannot be pushed into the product through the cord entry hole when such displacement results in damage to the cord or exposure of the cord to a temperature higher than that for which the cord is rated or can reduce spacings, such as to a metal strain-relief attachment, below the minimum required values.

11.3.2.3 A metal strain-relief clamp or band (without auxiliary protection) has been determined to be suitable with Type SJ, S, SJT, ST or similar jacketed cords. A metal strain-relief clamp or band has been determined to be suitable with Type SV, SP-2, SPT-2, or SVT cords only when nonconducting auxiliary mechanical protection is provided over the cord.

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

11.3.2.4 effective December 31, 2008

11.3.2.5 When tested in accordance with 82.1.1 – 82.1.3, the strain-relief means provided on the flexible cord shall be capable of withstanding for one minute, a pull of 35 pounds (15.9 kg) applied to the cord, with no evidence of stress on the interior connections.

11.3.3 Bushings

11.3.3.1 At the point at which a supply cord passes through an opening in a wall, barrier, or the overall enclosure, there shall be a bushing or a determined equivalent that shall be secured in place, and shall have a smooth, well-rounded surface against which the cord tends to bear. When other than a jacketed cord is used and the wall or barrier is of metal, an insulation bushing shall be provided.

11.3.3.2 When the cord hole is in porcelain, phenolic composition, or another rated nonconducting material, a smooth, well-rounded surface is determined equivalent to a bushing.

11.3.3.3 Ceramic materials and some molded compositions are capable of being used for insulating bushings.

11.3.3.4 Vulcanized fiber is not prohibited from being used when the bushing is not less than 3/64 inch (1.2 mm) thick and is formed and secured in place so that it will not be affected adversely by conditions of ordinary moisture.

11.3.3.5 A separate soft-rubber, neoprene, or polyvinyl chloride bushing shall only be used on a supply cord where the cord enters the frame of a motor or the enclosure of a capacitor that is physically attached to a motor when the bushing is:

a) Not less than 3/64 inch (1.2 mm) thick and

b) Located so that it will not be exposed to oil, grease, oil vapor, or other substances that tend to have a deleterious effect on the compound used.

11.3.3.6 A bushing of any of the materials specified in 11.3.3.5 on a supply cord anywhere in a product is acceptable when it is used in conjunction with a type of cord for which an insulating bushing is not required. The edges of the hole in which such a bushing is used are required to be free from burrs, fins, and other conditions that could damage the bushing.

11.3.3.7 At any point in a product, a bushing of the same material as, and molded integrally with, the supply cord is capable of being used on a Type SP-2 or heavier cord, when the thinnest section is not less than 1/16 inch (1.6 mm) thick at the point where the cord passes through the enclosure.

11.3.3.8 An insulated metal grommet to be used in place of an insulating bushing meets the intent of the requirement, when the insulating material used is not thinner than 1/32 inch (0.8 mm) and completely fills the space between the grommet and the metal in which the grommet is mounted.

12 Other Field-Wiring Connections

12.1 General

12.1.1 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.

12.1.2 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.

12.1.3 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. When duplicate terminals or leads are not used and there is no provision to prevent looping an unbroken wire around or under one terminal, the information in 90.11 shall be included in the installation wiring diagram/instructions.

12.1.3 effective December 31, 2008

12.2 Field-wiring compartment

12.2.1 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.

12.2.2 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.

12.2.3 Where it is possible for damage to field-wiring insulation to 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 wording determined to be the equivalent) marked in the wiring area: ″CAUTION – When Making Installation, Route Field Wiring Away From Sharp Projections, Corners And Internal Components.″

12.2.4 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.

12.2.4 effective December 31, 2008

12.3 Power-limited circuits

12.3.1 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 volts 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.

Compliance with this requirement 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.

12.3.1 revised July 14, 2005

12.4 Field-wiring terminals (general application)

12.4.1 A field-wiring terminal to which field-wiring connections are made shall comply with the requirements in:

a) 12.4.2 – 12.4.5;

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

c) The Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL 486A;

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.

12.4.2 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 of plated steel have been determined to meet the requirements.

12.4.3 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 is appropriate for use for the connection of a 14 AWG (2.1 mm^2) and a No. 4 (2.8 mm) diameter screw is appropriate for use for the connection of a 19 AWG (0.65 mm^2) or smaller conductor.

12.4.4 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 used if they provide equivalent thread security of the wire-binding screw.

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 when used with a No. 6 (3.5 mm) diameter or smaller screw.

12.4.5 When two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be used 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.

12.5 Field-wiring terminals (qualified application)

12.5.1 Any of the following terminal configurations are suitable for connection of field wiring when all of the conditions in 12.5.2 are met:

a) Telephone-Type Terminals – Nonferrous terminal plates using a narrow, V-shaped slot for securing of a conductor in a special post design (requires a 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 control unit with instructions for their installation;

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

e) Other Terminals – Other terminal connections are not prohibited when determined to be equivalent to (a) – (d) and are limited to the same restrictions.

No Text on This Page

12.5.2 Any of the terminal configurations listed in 12.5.1 are appropriate for connection of field wiring provided all of the following indicated conditions are met.

a) When a special tool is required for connection, it shall be provided and its use indicated on the installation wiring diagram by name of the manufacturer and the model number or equivalent.

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

c) The wire size to be used shall be rated for the current-carrying capacity of the circuit application.

d) Removal of a lead for testing or routine servicing, including detection, location, and correction of installation wiring faults, is prohibited.

e) A means for testing for an open and a ground fault on the circuit(s) to which the wiring is connected shall be incorporated into the control unit or indicated on the installation wiring diagram.

f) The terminal assembly shall comply with the Tests on Special Terminal Assemblies, Section 76.

12.6 Field-wiring leads

12.6.1 General

12.6.1.1 Leads provided for splice connections shall be minimum 6 inches (153 mm) long.

Exception: The free-lead length is not prohibited from being less than 6 inches long when it is evident that the use of a longer lead results in damage to the lead insulation or product, or in a risk of fire, electric shock, or injury to persons.

12.6.1.2 A means of strain relief shall be provided for the field wiring leads, and all internally connected wires which are subject to movement in conjunction with the installation, operation, or servicing 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.

12.6.1.3 Each lead used for field connections or an internal lead subjected to movement or handling during installation and servicing shall be capable of withstanding for 1 minute a pull of 10 pounds (4.54 kg) without any evidence of damage or of transmitting the stress to internal connections.

12.6.2 High-voltage circuits

12.6.2.1 A lead provided for field connection to a high-voltage circuit shall not be smaller than 18 AWG (0.82 mm^2), and the insulation, when of rubber or thermoplastic, shall be minimum 1/32 inch (0.8 mm) thick.

12.6.3 Power-limited circuits

12.6.3.1 A lead provided for field connection to a low-voltage, power-limited circuit shall be no smaller than 22 AWG (0.32 mm^2) and the insulation shall be a minimum of 1/64 inch (0.4 mm) thick.

Exception: Solid copper leads as small as 26 AWG (0.13 mm^2) are to be used only when:

a) The current does not exceed 1 ampere for lengths up to 2 feet (61 cm) or 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 strain-relief requirement specified in the Strain-Relief Test, Section 82; and

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

12.7 Cords and plugs

12.7.1 Cords and cord connectors shall not be used for products not intended to be moved or relocated, or where the desirability of the product being readily detachable has not been demonstrated.

12.7.2 Cords and cord connectors shall be rated for the current and voltage used.

13 Internal Wiring

13.1 General

13.1.1 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.

13.1.2 Internal wiring shall be routed and secured so that the wires and electrical connections are not subjected to stress or mechanical damage.

13.1.3 A hole in a wall within the overall enclosure of a product through which insulated wires pass, shall be provided with a bushing or shall have smooth, rounded surfaces.

13.1.4 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.

13.1.5 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.

13.1.6 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.

13.1.7 A lead or a cable assembly connected to a part mounted on a hinged cover shall be long enough to permit the full opening of the cover without applying stress to the lead or the connections. The lead shall be secured, or equivalently arranged, to reduce the risks of abrasion of the insulation and jamming of the leads between parts of the enclosure.

13.1.8 Metal clamps and guides used for routing stationary internal wiring shall be provided with smooth, well-rounded edges. Auxiliary nonconducting mechanical protection shall be provided:

a) Under a clamp at which pressure is exerted on a conductor having thermoplastic insulation less than 1/32 inch (0.8 mm) thick and no overall braid and

b) On any wire(s) that is subject to motion.

13.1.9 Wires shall be routed away from sharp edges (such as those found on screw threads, burrs, and fins), moving parts, and similar hazards, which tend to damage the wire insulation.

13.1.10 Insulated wires bunched and passed through a single opening in a metal wall within the enclosure of the product are not prohibited when the other requirements of this standard are met.

13.1.11 Supplementary insulation shall be applied to internal wiring that involves a risk of electric shock and is exposed during user servicing.

13.1.12 Internal wiring of circuits that operate at different potentials shall be separated by barriers or shall be segregated, unless the conductors of the circuits of lower voltage are provided with insulation for the highest voltage.

13.1.13 Clamping, routing, or equivalent means that ensures permanent separation may accomplish segregation of insulated conductors.

13.2 Splices and connections

13.2.1 All splices and connections shall be mechanically secure and shall be investigated and determined to provide intended electrical continuity. A soldered connection shall be made mechanically secure before being soldered. Consideration shall be given to vibration when investigating electrical connections. Pressure-wire connectors have been determined to comply with the requirements.

13.2.2 A splice shall be provided with insulation determined to be the equivalent to that of the wires involved when permanence of spacing between the splice and other metal parts is incapable of being maintained.

13.2.3 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.

13.2.4 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.

13.3 Connectors and receptacles

13.3.1 A receptacle or connector of the multiple-pin type shall be suitable for the current and voltage to which it is to be subjected.

14 Protective Devices

14.1 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.

14.2 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 volts.

14.3 Fuseholders, fuses, and circuit breakers shall be rated for the application.

14.4 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. The overcurrent protection provided shall be as specified in Article 240 in ANSI/NFPA 70. See 58.3.3.

14.4 effective December 31, 2008

15 Current-Carrying Parts

15.1 Except as noted in 15.2, current-carrying parts shall be of silver, copper, a copper alloy, stainless steel, aluminum, or other nonferrous material intended for the application.

15.2 Plated steel meets the intent for some secondary-circuit or primary-circuit parts (such as capacitor terminals) when a glass-to-metal seat is necessary and for leads or threaded studs of semiconductor devices. Blued steel or steel with an equivalent corrosion resistance meets the intent for the current-carrying arms of mechanically or magnetically-operated leaf switches, and within a motor and motor governor including the motor terminals, or when the temperature is in excess of 100°C (212°F) during the intended operation.

15.3 Bearings, hinges, and the like shall not be used as current-carrying parts.

16 Spacings

16.1 A product shall provide maintained spacings between uninsulated live parts and the enclosure or dead-metal parts, and between uninsulated live parts of opposite polarity. The spacings shall not be less than those indicated in Table 16.1.

Table 16.1
Minimum spacings

Point of application	Minimum spacings				
	Voltage range, volts	Through air, inch	(mm)	Over surface, inch	(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:					
(General application)[a]	0 – 30	3/16	4.8	3/16	4.8
	31 – 150	1/4	6.4	1/4	6.4
	151 – 300	1/4	6.4	3/8	9.5
Installation wiring terminals, except solder-type terminals (special application, see 12.5.1)	0 – 30	1/8	3.2	1/8	3.2
	31 – 150	3/16	4.8	3/16	4.8
	151 – 300	1/4	6.4	1/4	6.4
Rigidly clamped assemblies:[b]					
100 volt-amperes maximum	0 – 30	1/32[c]	0.8	1/32[c]	0.8
Over 100 volt-amperes	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	1/16	1.6
	31 – 150	1/8	3.2	1/4	6.4
	151 – 300	1/4	6.4	3/8	9.5

[a] Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. In no case shall the wire be smaller than 18 AWG (0.82 mm^2).

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

Table 16.1 Continued on Next Page

Table 16.1 Continued

Point of application	Minimum spacings				
	Voltage range, volts	Through air, inch	(mm)	Over surface, inch	(mm)
[c] Spacings less than those indicated are permitted for printed-wiring board traces of circuits involving integrated circuits and similar components where the spacing between adjacent connecting wires on the component is less than 1/32 inch (0.8 mm).					

16.2 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.

16.3 The spacing requirements in Table 16.1 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 16.1.

16.4 The “To-walls-of-enclosure” spacings indicated in Table 16.1 are not to be applied to an individual enclosure of a component part within an outer enclosure.

16.5 An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material used where spacings would otherwise be insufficient, shall be minimum 0.028 inch (0.71 mm) thick; except that a liner or barrier that is minimum 0.013 inch (0.33 mm) thick meets the intent when used in conjunction with a minimum of one-half of the through-air spacing required. The liner shall be located so that it will not be affected adversely by arcing.

16.6 Insulating material having a thickness less than that specified in 16.5 meets the intent when it has been determined to have equivalent mechanical and electrical properties.

16.7 Film-coated wire is identified as a bare current-carrying part in determining compliance of a device with the spacing requirements, but the coating is suitable as turn-to-turn insulation in coils.

16.8 The spacings within snap switches, lampholders, and similar wiring devices supplied as part of a unit are determined under other requirements for such devices and is not required to comply with the requirements of Table 16.1. See General, Section 2.

17 Insulating Material

17.1 Uninsulated live parts involving risk of fire, electric shock, or electrical-energy/high-current levels shall be mounted on porcelain, phenolic composition, or other material that has been determined acceptable for the application.

17.2 Vulcanized fiber is not prohibited from being used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts when shrinkage, current leakage, or warpage introduces a risk of fire, electric shock, or injury to persons. Thermoplastic materials used for the direct or indirect support of uninsulated live parts involving a risk of fire, electric shock, or electrical-energy/high-current shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

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

17.4 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.

18 Printed-Wiring Boards

18.1 Printed-wiring boards shall be suitable for the application. 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, Section 16. 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.

18.2 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.

19 End-of-Line Devices

19.1 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 back box, 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 fire 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.

19.1 revised July 14, 2005

20 Voltage-Dropping Resistors

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

21 Coil Windings

21.1 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).

21.1 effective December 31, 2008

21.2 The insulation of coil windings of relays, transformers, and similar components, shall be such as to resist the absorption of moisture.

21.3 Film-coated wire is not required to have an additional treatment to prevent moisture absorption.

22 Components

22.1 Switches

22.1.1 A switch provided as part of a 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.

22.2 Lampholders and lamps

22.2.1 Lampholders and lamps shall be rated for the circuit in which they are employed when the product is operated under any condition of intended service.

22.2.2 Except for circuits operating at 30 volts, root-mean-square (rms), 42.4 volts direct current (DC) or 42.4 volts peak, or less, a lampholder shall be installed so that uninsulated live parts other than a screw shell will not be exposed to contact by persons removing or replacing lamps.

22.2.3 The color coding of lamps or equivalent indicators employed as part of a product shall not be the sole means of identifying the function of the indicator.

Exception: Lamps and indicators used by service personnel for diagnostic purposes, provided that they are identified in the product's installation instructions/manual.

No Text on This Page

22.3 Operating mechanisms

22.3.1 Operating parts, such as light-duty relays and similar devices, shall be protected against fouling by dust or by other material that may adversely affect their intended operation, by individual protection or dust-tight cabinets. A relay employing contacts having a wiping action does not require any special protection against fouling by dust.

22.3.2 The assembly of an operating mechanism included as a part of a control unit or accessory shall be such that it will not be adversely affected by any condition of intended operation.

22.3.3 Moving parts shall have sufficient play at bearing surfaces to prevent binding.

22.3.4 Provision shall be made to prevent adjusting screws and similar adjustable parts from loosening under the conditions of actual use.

22.3.5 Manually-operated parts shall withstand the stresses to which they will be subjected in operation.

22.3.6 An electromechanical device shall be constructed to provide reliable and positive electrical and mechanical performance under all conditions of intended operation.

22.4 Across-the-line components

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

22.4.1 effective December 31, 2008

22.4.2 A component is considered to be across the high-voltage supply circuit when, in a shorted condition, a current of more than 1 ampere 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 ampere or less by a fixed impedance or a protective device rated 1 ampere or less.

22.4.2 effective December 31, 2008

22.4.3 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.

22.4.3 effective December 31, 2008

23 Batteries

23.1 Rechargeable storage-type used as standby power source

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

23.1.2 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.

23.1.3 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.

23.1.4 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.

23.1.5 The battery shall be protected against excessive loading or charging current by a fuse or other overcurrent protective device.

23.2 Primary dry-cell batteries

23.2.1 When a battery or set of batteries is used as the main source or the non-rechargeable standby source of power of a product intended for fire signaling, it shall meet the requirements of the Primary Batteries Tests, Section 81.

23.2.1 effective December 31, 2008

23.2.2 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.

23.2.2 effective December 31, 2008

23.2.3 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.

23.2.3 effective December 31, 2008

23.2.4 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.

23.2.4 effective December 31, 2008

23.2.5 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs), and strain relief provided for any leads. The polarity shall be indicated on the product either adjacent to the battery terminals or leads.

23.2.5 effective December 31, 2008

23.2.6 Connections to battery terminals shall be either by a lead terminating in a positive snap-action type clip, or a fixed butt-type connection which applies a minimum 6.6 N (1.5 pounds) force to each battery contact, 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.

23.2.6 effective December 31, 2008

23.2.7 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 (0.21 mm^2) stranded wire size with minimum 0.4 mm (1/64 inch) insulation and provided with strain relief.

23.2.7 effective December 31, 2008

23.3 Lithium batteries

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

23.3.1 effective December 31, 2008

23.3.2 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 UL 1642.

23.3.2 effective December 31, 2008

24 Grounding for Products Containing High-Voltage Circuits

24.1 A product which involves high-voltage circuits shall have provision for the grounding of all exposed dead metal parts that might become energized from circuits involving a risk of electric shock.

Exception: Metal parts as described in (a) – (d):

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

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

c) Panels and covers that do not enclose uninsulated live parts when wiring is positively separated from the panel or cover so that it is not liable 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 0.8 mm (1/32 inch) thick.

24.2 On fixed equipment, the provision of a knockout or other opening in a metal enclosure for the connection of metal-clad cable, conduit, metal raceway, or the like is permitted as a means for grounding.

24.3 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.

24.4 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: Metal parts as described in the Exception to 24.1.

24.5 The following circuits of fire alarm system circuits shall be bonded to ground under the indicated conditions:

a) Alternating current circuits less than 50 volts:

1) Where supplied by transformers if the transformer supply system exceeds 150 volts to ground.

2) Where supplied by transformers if the transformer supply system is ungrounded.

3) Where installed as overhead conductors outside of buildings.

b) Alternating current circuits of 50 volts and over:

1) Where the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts.

2) Where the system is nominally rated 240/120 volts, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor.

c) Direct-current circuits operating at 51 – 300 volts.

Exception: Power-limited direct-current fire alarm circuits having a maximum current of 0.030 amperes.

24.6 All bonding to ground connections shall be by a positive means, such as by clamping, riveting, brazing, welding, or by being a bolted or screwed connection. The bonding connection shall penetrate nonconductive coatings such as paint. Bonding around a resilient mount shall not rely on the clamping action of rubber or similar material.

24.7 A bolted or screwed connection that incorporates a star washer or serrations under the screw head for penetrating nonconductive coatings is identified as complying with 24.6.

24.8 Where the bonding means depends upon screw threads, the use of two or more screws or two full threads of a single screw engaging metal is in compliance with 24.6.

24.9 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 24.1.

Table 24.1
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

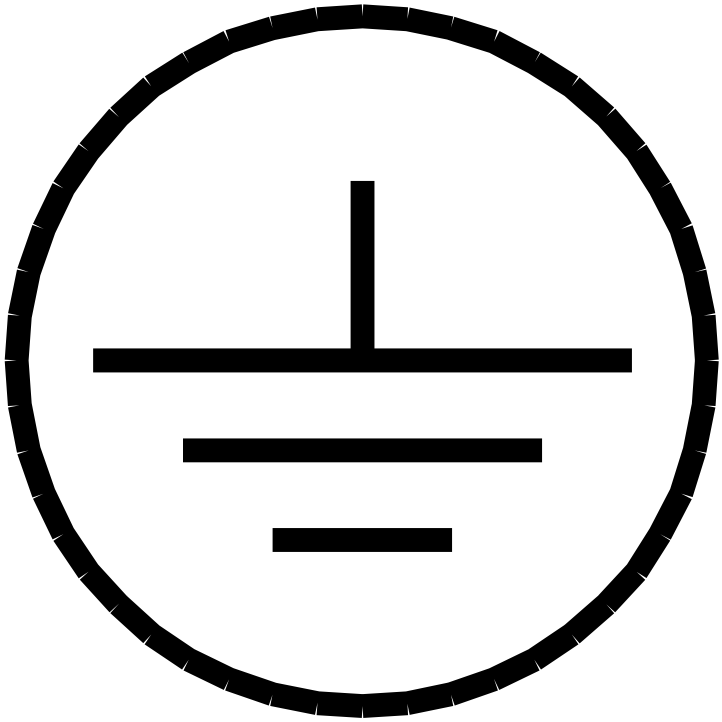
[a] Or equivalent cross-sectional area.

24.10 The size of a copper or aluminum conductor used to bond an electrical enclosure shall be based on the rating of the branch-circuit overcurrent device by which the equipment will be protected. The size of the conductor shall be in accordance with Table 24.1.

24.11 Splices shall not be used in wire conductors used for bonding.

24.12 A wire-binding screw or a pressure wire connector intended for the connection of an equipment-grounding conductor shall have a green-colored head or shall be plainly identified as such by being marked ″G,″ ″GR,″ ″GND,″ ″Ground,″ ″Grounding,″ or the like, or with the Symbol 5019 graphic from IEC Publication 60417-1 shown in Figure 24.1, or by a marking on the wiring diagram provided on the product. The wire-binding screw or pressure wire connector shall be located so that it is not able to be removed during intended servicing of the product. When used alone, the Symbol 5019 graphic from IEC Publication 60417-1 shall be defined in the installation instructions provided with the equipment.

Figure 24.1
International electrical symbol



24.13 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.

24.14 The grounding conductor in a flexible cord shall be green with or without one or more yellow stripes. The grounding conductor shall be secured to the frame or enclosure of the product by means of a screw, rivet, or similar equipment that is not removable during intended servicing not involving the supply cord. Solder shall not be used alone for securing the grounding conductor. The grounding conductor shall be connected to the grounding terminal of an attachment plug.

24.15 When a means for grounding is provided on the product, even though it is not required, it shall comply with the requirements in 24.1 – 24.14.

24.16 Metal-to-metal hinge-bearing members for doors or covers are considered to meet the requirement for bonding the door or cover to ground, when a multiple bearing pin type (piano-type hinge) is used.

Exception: Slip-joint or similar, hinge-bearing members are not required to comply with this requirement when the resistance between the two parts connected by the bonding element is not more than 0.1 ohm. The resistance shall be determined by a resistance-measuring instrument. When unacceptable results are recorded, an alternating or direct current of at least 20 amperes from a power supply of not more than 12 volts shall be passed between the two parts connected by the bonding element. The resulting drop in potential and the test current shall be measured between the two points. The resistance in ohms shall be determined by dividing the drop in potential in volts by the current in amperes.

25 Servicing Protection

25.1 General

25.1.1 Uninsulated live parts of high-voltage circuits, hazardous moving parts, sharp corners and projections shall be formed, located, guarded, or enclosed so as to prevent contact by persons during servicing such as relamping, fuse or rod replacement, battery replacement, adjusting controls, and routine maintenance.

25.2 Trained service personnel

25.2.1 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 152 mm (6 inches), then protection by properly applied insulating tape, barriers, or equivalent, shall be provided.

Exception: Products complying with the Electric Shock Current Test, Section 72.

25.2.2 In lieu of the minimum 152 mm (6 inch) 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.″

25.2.3 Uninsulated live parts or moving parts involving a risk of injury shall be located, guarded, or enclosed so as to reduce the risk of contact by persons during servicing conditions such as relamping, changing fuses, adjusting controls, and operating switches.

25.3 Antenna terminal discharge assembly

25.3.1 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 megohms, a minimum wattage rating of 1/2 watt, 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 megohms.

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 watt.

25.3.2 The maximum value of 5.2 megohms specified in 25.3.1 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance.

PROTECTION AGAINST INJURY TO PERSONS

26 General

26.1 When the operation and maintenance of a product by the user involves a risk of injury to persons, protection shall be provided to reduce the risk.

26.1 effective December 31, 2008

26.2 When investigating a product with regard to 26.1, determination shall be given to foreseeable misuse of the product.

26.2 effective December 31, 2008

26.3 An accessory that is made available or recommended by the manufacturer for use with the basic product shall be included in the evaluation of the product.

26.3 effective December 31, 2008

26.4 The suitability of a guard, a safety release, an interlock and similar devices, and whether such a device is required, is to be determined from an investigation of the complete product, its operating characteristics, and the risk of injury to persons. The investigation is to include evaluation of the results of breakdown or malfunction of any one component, but not more than one component at a time, unless one event contributes to another. When the investigation shows that breakdown or malfunction of a component results in a risk of injury to persons, the component shall be investigated for reliability.

26.4 effective December 31, 2008

26.5 A risk of injury to persons is possible when one or more of the following conditions exist:

a) Power-operated moving parts such as gears and linkages are accessible during intended operation or maintenance and are capable of causing a cut or laceration;

b) Sharp edges, burrs, or projections are present during use or servicing;

c) The stability of a product is such that it is capable of causing injury to persons (see Stability, Section 29);

d) There is a possibility that a part of the body is endangered or that clothing is capable of being entangled by a moving part.

26.5 effective December 31, 2008

27 Telescoping Antenna

27.1 A telescoping-type antenna terminating in an end that is capable of constituting a risk of puncture shall be provided with a minimum 6-mm (0.231-inch) diameter button or ball on the end that complies with the Antenna End-Piece Secureness Test, Section 83.

27.1 effective December 31, 2008

28 Sharp Edges

28.1 An enclosure, edge, frame, projection, guard, opening, handle, or similar construction shall be smooth and free from sharp edges that are capable of injury to persons during intended maintenance and use.

Exception: A sharp edge that must be exposed to enable the product to perform its intended function.

28.1 effective December 31, 2008

28.2 For edges where the degree of sharpness cannot be determined by inspection, compliance with 28.1 is determined by the test procedure in the Standard for Test for Sharpness of Edges on Equipment, UL 1439.

28.2 effective December 31, 2008

29 Stability

29.1 Under all conditions of servicing and intended use, a fully assembled product shall not become physically unstable to the degree that creates a risk of injury to operators or service personnel.

29.1 effective December 31, 2008

29.2 A product shall not tip over when tilted 10 degrees from its intended, upright position, while all doors, covers, gates, drawers, and similar parts are in place and closed, and all casters and jacks, when provided, are in their most unfavorable position.

Exception: For fixed or stationary equipment without casters where specialized handling is required to transport the product, this test is to be performed after the equipment is installed as intended.

29.2 effective December 31, 2008

29.3 The requirements in 29.4 – 29.8 apply to all freestanding products. A freestanding product is defined as one that is floor standing and not intended to be secured to other units or to the floor or other parts of the building.

29.3 effective December 31, 2008

29.4 In conducting the tests described in 29.5 – 29.7, the equipment shall be installed as intended. All casters and jacks, when provided, are to be placed in their most unfavorable positions, and wheels are to be locked or blocked. However, when casters are being used only to transport the product, and jacks are lowered after installation, then the jacks (and not the casters) are to be used in their most unfavorable position for the test, consistent with reasonable leveling of the product.

29.4 effective December 31, 2008

29.5 A freestanding product that has an external surface (work top or ledge) at a height not exceeding 39-3/8 inches (1.00 m) from the floor and that is prone to being stepped on or sat upon, shall not tip over when a continuous downward force of 179.8 pounds-force (800 N) is applied to that surface at the point of maximum moment. For this test, all doors, covers, gates, drawers, and similar parts shall be in place and closed.

29.5 effective December 31, 2008

29.6 With regard to the requirement in 29.5, delicate parts such as keyboards, control panels, or spools are not determined as prone to being stepped on or sat upon.

29.6 effective December 31, 2008

29.7 A freestanding product more than 39-3/8 inches (1.00 m) high and weighing more than 55.1 pounds (25.0 kg) shall not tip over when a force equal to 1/5 the weight of the unit but not more than 56.2 pounds-force (250 N) is applied in any direction, except upward, at a height not exceeding 78-3/4 inches (2.00 m) from the floor. For this test, all doors, drawers, frames, and the like that can be opened for operator or serviceman servicing are to be opened and in the most unfavorable position. Separate tasks are to be performed when operator and service extensions are different or when special stabilizers are used in accordance with 29.8.

29.7 effective December 31, 2008

29.8 A stabilizing means is not prohibited from being used to improve stability when doors, drawers, and the like are opened. The stabilizing means shall be automatic in operation or interlocked when associated with user use. For service personnel, where it is not automatic in operation, a conspicuous marking shall be provided to caution the personnel on its use. See 89.1.23.

29.8 effective December 13, 2008

PERFORMANCE

GENERAL

30 Details

30.1 Tests and voltages

30.1.1 Except as otherwise indicated, the performance of a product shall be investigated by subjecting a representative sample in commercial form to the tests described in Section 31 – 86.

30.1.2 Unless otherwise specified, the test voltage for each test of a product is to be as indicated in Table 30.1 at the rated frequency of the product.

Table 30.1
Test voltages

Table 30.1 revised July 14, 2005

	Product rated voltage, nameplate	Test voltage
60 cycle, 50/60 cycle	110 – 120 220 – 240	120 240
Rated frequency	Other	Maximum marked rating
DC	Battery circuit	Marked nominal battery voltage
50 cycle	110 – 120	120
	220	220
	240	240

30.1.3 Radio frequency transmitters and equipment intended to be connected to the public telephone network shall comply with applicable Federal Communications Commission (FCC) rules and regulations.

30.1.4 When a product must be mounted in a definite position in order to function as intended, it shall be tested in that position.

30.1.5 All measurements are to be made with a true RMS meter or an oscilloscope.

30.2 Maximum rated load

30.2.1 A product shall operate as intended and without the risk of fire, electric shock, or injury to persons with all external circuits connected to maximum rated load.

30.2.2 Maximum rated load is that value of impedance which causes rated current to flow in the external circuit or the maximum number of specific devices or appliances, as specified in the installation instructions/wiring diagram, connected to the external circuit, with the input voltage to the product adjusted to the value determined by 30.1.2.

30.2.3 Units that are provided with connectors for the installation of accessories or with open card slots, or both, shall be subjected to the tests in this standard with such connectors or card slots, or both, loaded to the maximum rated output capability for the unit specified by the manufacturer.

OPERATION TESTS

31 Specifics

31.1 A product shall be capable of operating for all conditions of its intended performance when used in conjunction with initiating devices, notification appliances, power supplies, and interconnected equipment to form a system of the service specific type indicated in the marking and shown in the installation wiring diagram/instructions.

31.2 To determine compliance with 31.1, initiating devices, notification appliances, interconnected equipment, and power-supply circuits are to be connected to the product as specified by the installation wiring diagram/instructions to form a typical system, and the system operated for each condition of its intended performance.

31.3 The items in (a) – (d) used for testing are to be those specified by the installation wiring diagram/instructions of the product. Substitute devices, unless otherwise indicated, are not prohibited from being used where they produce equivalent circuit loading and actuation of the product.

a) Initiating devices (fire alarm boxes, heat detectors, smoke detectors, sprinkler supervisory switches, proof sensors, and similar devices);

b) Notification appliances (bells, strobes, speakers, and similar appliances or parts);

c) Releasing devices (solenoids and valves); and

d) Interconnected equipment (control-unit accessories, other control units, annunciators, releasing devices, door-hold release devices, emergency exit locks, HVAC equipment, supplementary devices, and the like).

31.4 During the tests in Sections 31 – 57, each power-supply circuit shall be supplied from a source of rated frequency and voltage as specified in 30.1.2.

31.5 To determine if a product complies with those requirements that specify the application of a circuit fault, adverse condition, or malfunction of specified equipment/components, the investigation is to start with the representative system combination in the normal supervisory condition. The fault condition is then to be separately introduced, the results noted, the fault removed, and the system restored to the normal supervisory condition before the next fault is introduced.

LOCAL SERVICE

32 General

32.1 Sections 32 – 34 cover the operation requirements for control units and accessories intended for local service.

32.2 The product shall comply with the following:

a) Power Supplies, Section 50;

b) Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51;

c) Trouble Signals, Section 52;

d) Components – Monitoring for Integrity, Section 53;

e) Software, Section 54;

f) Features, Section 55;

g) Combination Systems, Section 56; and

h) Interconnected Fire Alarm Units, Section 57.

No Text on This Page

33 Signaling

33.1 General

33.1.1 The operation of any initiating device shall cause the system to produce a clearly defined signal of the type for which the combination is designed.

33.1.2 The time periods for processing and activation of signals in a worst case loaded system shall be as follows:

a) Automatic processing and activation of

1) Alarm notification appliances,

2) Local alarm and/or supervisory signal annunciation and/or actuation,

3) Pre-programmed emergency audio announcement,

4) Commencement of programmed delays, and/or

5) Other local fire safety functions associated with the protected premises

shall not be greater than 10 seconds from the initiation of an alarm or supervisory condition, or operation of a manually-activated switch.

b) Trouble signals and their restoration to normal shall be annunciated, including actuation of pre-programmed relays, open collector outputs, and the like, within 200 seconds of the occurrence of the adverse condition, fault, or the restoration to normal.

Exception No. 1: Trouble signals identifying an inoperative transmitter in a low-power radio-frequency system that meet the Exception to 51.5.8.

Exception No. 2: The initial battery trouble signal annunciation from a battery-operated low-power radio-frequency transmitter that complies with 50.4.1.

33.1.2 effective December 31, 2008

33.1.3 Alarm, supervisory, and trouble signals shall be indicated at the following locations:

a) Operator interface at the protected premises for local-type service and

b) Building fire command center for emergency voice/alarm communications systems.

33.1.3 effective December 31, 2008

33.1.4 Fire alarm signals, supervisory signals, trouble signals, and other signals shall result in distinctly different annunciation.

33.2 Display information

33.2.1 Systems serving two or more zones shall visually identify the zone of origin of the status change.

33.2.2 The visual annunciation shall be capable of displaying all zones having a status change. Where all zones or status changes are not displayed simultaneously, all the following conditions apply:

a) The display shall indicate the initial status change for the highest priority type signal.

b) An indication for each type (such as fire alarm, fire trouble, sprinkler supervisory) of active non-displayed status changes shall be continuously visible during any off-normal condition.

c) A visual indication showing deactivated alarm notification appliances as required by 33.3.4.

d) The non-displayed status changes shall be capable of being displayed only by manual operation(s).

e) The display controls shall not interfere with the normal operation of the unit.

f) When concurrent signals are received, they shall be indicated as follows in descending order of priority:

1) Signals associated with life safety.

2) Signals associated with property safety.

3) Supervisory signals and trouble signals associated with life and/or property safety.

4) All other signals.

33.2.2 effective December 31, 2008

33.2.3 Non-electrical visual annunciation integral with a switch shall include obvious distinct indications for both the normal and off-normal position of the switch. Utilization of the switch position does not meet the intent of complying with this requirement.

33.2.3 effective December 31, 2008

33.2.4 Controls provided specifically for the purpose of manually overriding any automatic building and fire control functions intended to increase the level of life safety for occupants or control the spread of the harmful effects of fire (fire safety function), shall provide visible indication of the status of the associated control circuits.

33.2.4 effective December 31, 2008

33.3 Alarm signals

33.3.1 An alarm input signal shall automatically actuate notification appliance circuits necessary for evacuation and/or relocation.

33.3.2 Audible alarm notification circuits intended for evacuation shall have the capability of producing the American National Standards Institute's ANSI S3.41 audible emergency evacuation signal pattern, and shall be synchronized on a system basis.

Exception: When a system is intended to provide signaling to more than one notification zone, synchronization of the audible emergency evacuation signal pattern on a notification circuit basis in lieu of a system basis is acceptable. Specifics covering the installation constraints shall be clearly detailed in the installation wiring diagram/instructions for the control unit.

33.3.2 effective December 31, 2008

33.3.3 An alarm notification circuit intended to provide synchronization of visible alarm notification appliances shall comply with the parameters specified in the Standard for Signaling Devices for the Hearing Impaired, UL 1971.

33.3.4 Any manual or automatic means for turning off activated alarm notification appliances (silencing) shall comply with the following requirements:

a) Alarm signal deactivating of activated notification appliances of a control unit/system shall be indicated by a constantly displayed and identified visual indicator.

b) An alarm signal deactivating means left in the off-normal condition when there is no alarm shall activate an audible trouble signal until the means is restored to normal.

c) When any alarm signal deactivating means for an individual circuit/zone of a multiple-circuit control unit/system is activated, there shall be an indication of the related deactivated notification circuit(s) or zone(s) by an identified lamp(s) or other visual annunciation, and operation of the alarm notification appliances by any other notification appliance circuit having its alarm deactivation means in the normal position shall not be prevented.

d) An alarm-signal deactivation switch shall be either:

1) A key-lock type, with the key removable only in the normal position;

2) Located inside of a locked enclosure;

3) Access limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

e) The activation of the alarm signal deactivating means during an alarm condition shall not result in resetting any actuated circuit other than the notification appliance circuit(s) or zone(s) being deactivated.

f) The alarm condition shall be indicated and maintained by a lamp or other visual indicator with the deactivating means activated.

g) When alarm signal deactivation can be accomplished in a selective manner, the visual indicator(s) referenced in (a) shall distinguish notification appliance circuit(s) or zone(s) that have been deactivated from notification appliance circuit(s) or zone(s) that are still energized.

h) After deactivating notification appliance circuit(s) or zone(s) resulting from an alarm in one alarm initiating device circuit, addressable alarm initiating device circuit, or addressable fire alarm initiating device, a subsequent alarm in any other system fire alarm initiating device circuit, addressable alarm initiating device circuit, or addressable initiating device shall cause all previously activated notification appliance circuit(s) or zone(s) to reactivate.

Exception No. 1: When a system is intended to provide signaling service to two or more physically separated buildings or zones, reenergization of the notification appliance circuits only on a zone basis meets the intent of the requirement. Specifics covering installation constraints shall be clearly detailed in the control unit installation wiring diagram/instructions.

Exception No. 2: Systems are not prohibited from having provision to automatically disable reenergizing alarm notification circuits due to subsequent activation of other addressable smoke detectors of the same type located in the same room or space as the initial activated device. Specifics covering installation constraints shall be clearly detailed in the control unit installation wiring diagram/instructions.

33.3.4 (a) and (d) effective December 31, 2008

33.3.5 An alarm signal of a control unit/system shall be maintained continuously (locked in) by the control unit/system until a resetting device in the control unit/system is operated manually.

33.3.6 A coded alarm signal shall consist of not less than three complete rounds of the number transmitted and each round shall consist of not less than three impulses.

33.3.7 For a coded control unit intended for connection only to non-coded initiating devices, the alarm signal shall either be locked in or the system shall complete the required number of rounds of alarm signal activation without interruption due to restoration of an initiating device or fault on the initiating device circuit or signaling line circuit.

33.3.7 effective December 31, 2008

33.4 Trouble signals

33.4.1 All trouble signals shall comply with Trouble Signals, Section 52.

33.5 Supervisory signals

33.5.1 The signal indication resulting from the operation of a product for supervisory signals shall automatically include distinctive audible and visual signals for both the off-normal and the restoration-to-normal conditions of the supervisory initiating devices. Cancellation of the off-normal signal is acceptable annunciation for the restoration signal.

Exception: For products whose operation provide, in addition to the above, the capability of selecting nonautomatic distinctive restoration-to-normal supervisory signals (locking in the supervisory signals until manually reset), the installation wiring diagram/instructions for the product shall include instructions for selecting the respective operation.

33.5.1 effective December 31, 2008

33.5.2 Supervisory signals shall be distinctive in sound from other signals used by the signaling system and this sound shall not be used for any other purpose other than to also indicate a system trouble condition. When the same sound is used for both supervisory and trouble signals, distinction between signals shall be indicated by a visible means and silencing of a trouble signal shall not prevent subsequent sounding of supervisory signals.

33.5.3 A coded supervisory signal shall consist of not less than 2 complete rounds of the number transmitted to indicate a supervisory off-normal condition and not less than one complete round of the number transmitted to indicate the restoration of the supervisory condition to normal.

33.5.4 A means for silencing a supervisory signal sounding appliance shall comply with all the following requirements:

a) Limiting access by being either:

1) Key operated with the key removable only in the normal position;

2) Located within a locked cabinet;

3) Limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

b) The supervisory condition is indicated and maintained by a lamp or other visual indicator.

c) Subsequent supervisory signals in other zones will reenergize the supervisory signal notification appliance(s).

d) A means that is left in the ″silence″ position, when there is no supervisory off-normal signal, shall cause the audible supervisory signal to sound until the means is restored to normal.

33.6 Other signals

33.6.1 There shall be a distinction between signals associated with fire protection and signals of other types, such as burglary or process monitoring.

33.6.2 When a common audible, as part of the operator interface, is employed for alarm annunciation for all types of signals, distinction shall be achieved visually.

33.6.3 When a common audible, distinct from alarm, is employed for trouble annunciation for all types of signals, distinction shall be achieved visually.

34 Emergency Voice/Alarm Communications and Telephone/Intercom Signaling

34.1 General

34.1.1 This section covers the additional performance requirements for equipment intended for emergency voice/alarm communications and/or two-way telephone/intercom communication service.

34.1.2 Equipment such as amplifiers for use in these systems shall comply with the applicable requirements in the Standard for Amplifiers for Fire-Protective Signaling Systems, UL 1711.

34.1.3 Microphone and/or telephone handset cables shall be either:

a) Monitored for integrity such that the occurrence of a single open fault results in a trouble signal or

b) In compliance with the Standard for Flexible Cord and Fixture Wire, UL 62.

34.1.3 effective December 31, 2008

34.1.4 All required annunciation shall be at the fire command center portion of the system. Where there are multiple fire command centers, the center in control shall be identified by a visible indication at that center.

34.1.4 effective December 31, 2008

34.1.5 Any switches utilized for the control of emergency voice/alarm and/or two-way telephone communications shall be either:

a) A key-lock type, with the key removable only in the locked position;

b) Located inside of a locked enclosure;

c) Access limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

d) Arranged to provide equivalent protection against unauthorized use.

34.1.5 effective December 31, 2008

34.2 Emergency voice/alarm communications

34.2.1 Functional sequence

34.2.1.1 In response to an initiating signal indicative of a fire alarm emergency, systems providing voice/alarm communication shall minimally be capable of providing the following functions:

a) Automatic activation of an evacuation signal to any or all zones in the system, consisting of a minimum of two cycles of the American National Standard Institute's ANSI S3.41 audible evacuation signal pattern, followed by a recorded evacuation message to any or all zones in the system.

b) Automatic alert tone (either separately produced or part of a pre-recorded message) of 3 – 10 seconds duration followed by a recorded message to any or all zones in the system. The alert tone/prerecorded message combination shall be repeated a minimum of three times. Preempting of the alert tone with a predetermined time delay is not prohibited.

c) Manual activation of an evacuation signal or recorded message on an all-call basis. Additionally, manual activation by zone is not prohibited.

34.2.1.1 effective December 31, 2008

34.2.1.2 When provided in addition to that described in 34.2.1.1(b), other functional sequences are not prohibited.

34.2.1.3 When provision is made for the manual selection of speaker zones for the purpose of initiating tonal, prerecorded voice, or live voice evacuation messages and/or signals, the manual selections shall override conflicting automatic zone selections. Likewise, manually initiated sources (tone generator, prerecorded message, or live voice) shall take precedence over automatically initiated sources.

34.2.1.4 For systems providing live-voice communication, manual paging shall automatically be given precedence over all other evacuation signals and prerecorded messages.

34.2.2 Display information

34.2.2.1 A continuously displayed visual indication shall be provided for the following conditions:

a) The on/off status of all speaker zones (zones are to be considered ″on″ when an evacuation signal, pre-alert tone, recorded message, or live voice message is being reproduced by the speakers of that zone, regardless of whether it was automatically or manually activated).

b) The off-normal status of all control switches (this includes zone select, manual evacuation, all-call, and page controls).

34.2.2.1 effective December 31, 2008

34.2.2.2 Nonelectrical visual annunciation integral with a switch shall include obvious distinct indications for both the normal and off-normal position of the switch. Utilization of the switch position does not meet the intent of complying with this requirement.

34.2.3 Monitoring integrity

34.2.3.1 Failure of any component in the audio chain (such as amplifiers, preamplifiers, malfunction of a pre-recorded message device, displacement of a pre-recorded message medium, primary tone generators, and interconnected wiring) resulting in the loss of emergency signaling capability shall cause an audible trouble signal. Compliance is to be verified with the system in the normal supervisory condition and repeated with the system in the alarm condition.

Exception: This requirement does not apply to amplifiers and tone generators that are enclosed as integral parts and provide signals to a single speaker.

34.2.3.2 Where the voice evacuation message is generated and controlled separately from the evacuation tone, failure of a prerecorded message device while the message is playing shall result in the system reverting to the evacuation tone within 30 seconds.

34.2.3.3 Emergency voice/alarm and/or two-way telephone/intercom communication systems sharing components, circuitry and installation wiring with non-fire systems shall comply with Combination Systems, Section 56.

34.3 Two-way telephone/intercom communication

34.3.1 Two-way telephone equipment, when operating in a common-talking (for example, conference or party-line) or selective-talking mode, shall be capable of communication with at least five instruments on-line simultaneously.

34.3.2 Two-way telephone communication service is not prohibited from being arranged so that alarm initiation is required before telephone communication can begin.

34.3.3 A telephone station provided for reporting a fire shall be arranged so that its use will automatically produce all of the signaling functions required of a manual fire alarm station and not require operator response for alarm initiation. Similarly, a station provided for reporting other emergencies shall automatically produce the signaling functions required by the emergency systems. A station for reporting a fire and for reporting other emergencies shall be equipped with a selection lever or equivalent means by which to initiate the signals appropriate for the condition (fire or emergency).

34.3.4 An audible and visible signal distinctive from any other alarm, supervisory, or trouble signal shall indicate operation of a telephone call station at the fire command center.

34.3.4 effective December 31, 2008

34.3.5 Where a selective-talk telephone service is provided, a distinctive visual indicator shall be furnished for each selectable circuit such that all circuits with telephone off-hook are continuously indicated.

34.3.5 effective December 31, 2008

34.3.6 A switch for silencing the audible call-in sounding appliance shall comply with all of the following:

a) Limiting access by being either:

1) Key operated with the key removable only in the normal position;

2) Located within a locked cabinet;

3) Limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

b) The call-in condition shall be continuously indicated and maintained by a lamp or other visual indicator.

c) Subsequent call-in signals in other telephone circuits shall result in the reenergization of the audible call-in signal.

d) A switch that is left in the ″silence″ position, when there is no call-in signal, shall cause the trouble signal to sound until the switch is restored to normal.

34.3.6 effective December 31, 2008

34.3.7 Telephone/intercom circuits shall be monitored for integrity such that a single wire-to-wire fault, single open circuit, or single ground fault results in both an audible and visual trouble indication.

34.3.7 effective December 31, 2008

34.3.8 When a station is configured as a hands-free or handset station, it shall either be protected against unauthorized use in accordance with the Standard for Manual Signaling Boxes for Fire Alarm Systems, UL 38, or employ a jack for connection of a portable handset.

RELEASING SERVICE

35 General

35.1 Sections 35 and 36 cover the performance requirements for systems intended to release an extinguishing agent or water.

35.2 The product shall comply with the following requirements:

a) Power Supplies, Section 50;

b) Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51;

c) Trouble Signals, Section 52;

d) Components – Monitoring for Integrity, Section 53;

e) Software, Section 54;

f) In Features, Section 55: Alarm verification, 55.2.1 – 55.2.3; Automatic drift compensation and/or smoke detector sensing chamber supervision, 55.5.1 – 55.5.3; Calibrated detector sensitivity testing, 55.6.1 – 55.6.4;

g) Combination Systems, Section 56; and

h) Interconnected Fire Alarm Units, Section 57.

36 Operation

36.1 General

36.1.1 The operation of any initiating device shall cause the system to produce a clearly defined signal and release actuation of the type for which the combination is designed.

36.1.2 The time periods for automatic processing and activation of signals in a worst-case loaded product/system shall be as follows:

a) Not greater than 10 seconds from the operation of abort or manual release switches or initiation of an alarm condition until the required output functions are executed.

b) Not greater than 10 seconds from the initiation of a supervisory condition until the required output functions are executed.

c) Trouble signals and their restoration to normal shall be annunciated within 200 seconds of the occurrence of the adverse condition, fault, or the restoration to normal.

36.1.2 effective December 31, 2008

36.1.3 A product acceptable for releasing device service shall provide for the connection of releasing actuating device(s), such as squibs, valves, solenoids, and the like.

36.1.4 Circuits extending to releasing actuating devices shall be monitored such that a trouble signal indicates the occurrence of a single ground, single open, or an adverse condition or fault that prevents the required operation of the system.

36.1.5 The electrical functionality of each releasing actuating device shall be monitored for integrity.

36.1.6 A multiple ground fault or short-circuit fault on releasing circuit(s) intended for connection to limited energy cable, that would prevent required operation, shall result in a trouble signal or alarm signal.

36.1.7 An automatic delay provided prior to release operation by a system shall be a maximum of 60 seconds, timed from a release initiation condition, either from the actuation of a single detector, or from the actuation of the second circuit or detector for cross-zone and single-zone multiple-detector, or a combination of the two operations as described in 36.5.1 – 36.7.2.

36.1.8 A product shall not activate releasing devices when the primary power is de-energized and all secondary power sources, other than those used solely to sustain time and date functions or volatile memory, are reduced from rated voltage to zero.

36.1.8 effective December 31, 2008

36.1.9 Where networked control units are employed for a single releasing device service application, such that initiating devices, abort stations, or control switches on one unit controls releasing devices on another unit, a trouble condition or manual disconnect function occurring at any one unit involved in the releasing function(s) shall be visibly and audibly annunciated at each of the other interconnected control units involved in the releasing function.

36.1.9 effective December 31, 2008

36.1.10 A system which:

a) Is intended for the release of Halon 1301 as described in Halon 1301 Fire Extinguishing Systems, NFPA 12A, and/or clean agents as described in Clean Agent Fire Extinguishing Systems, NFPA 2001,

b) Employs batteries as its standby operating power source, and

c) Is provided with a manual release circuit,

shall audibly and visually annunciate a trouble condition when the standby source is solely powering the product and is depleted to 85 percent of its nominal marked voltage, unless the installation instructions indicate that a mechanical manual release is to be additionally employed.

36.1.10 effective December 31, 2008

36.1.11 Operation of a disconnect switch or disable function shall cause a supervisory signal.

36.1.11 effective December 31, 2008

36.2 Signals

36.2.1 Alarm, trouble, supervisory, pre-discharge, and discharge/release signals shall be indicated at the operator interface for the system.

36.2.2 Fire-alarm, supervisory, pre-discharge, discharge/release, trouble, and other signals shall be distinctly annunciated.

36.2.3 Systems serving two or more zones shall visually identify the zone of origin of the status change.

36.2.3 effective December 31, 2008

36.2.4 The visual annunciation shall be capable of displaying all zones having a status change. Where all zones or status changes are not displayed simultaneously, all the following conditions apply:

a) The display shall indicate the initial status change for the highest priority type signal.

b) An indication for each type (alarm, supervisory, trouble, pre-discharge, discharge) of active non-displayed status changes shall be continuously visible during any off-normal condition.

c) A visual indication showing deactivated notification appliances as required by 36.2.8.

d) The non-displayed status changes shall be capable of being displayed only by manual operation(s).

e) The display controls shall not interfere with the normal operation of the unit.

f) When concurrent signals are received, they shall be indicated as follows in descending order of priority:

1) Signals associated with life safety;

2) Signals associated with property safety;

3) Supervisory signals and trouble signals associated with life and/or property safety; and

4) All other signals.

36.2.4 effective December 31, 2008

36.2.5 Nonelectrical visual annunciation integral with a switch shall include obvious distinct indications for both the normal and off-normal position of the switch. Utilization of the switch position does not meet the intent of complying with this requirement.

36.2.5 effective December 31, 2008

36.2.6 Systems intended for the release of Halon 1301 as described in Halon 1301 Fire Extinguishing Systems, NFPA 12A, and/or clean agents as described in Clean Agent Fire Extinguishing Systems, NFPA 2001, shall have provision for a pre-discharge notification appliance circuit.

36.2.6 effective December 31, 2008

36.2.7 All evacuation signals produced by the system shall have the capability of complying with the ANSI S3.41 Audible Emergency Evacuation Signal pattern.

36.2.7 effective December 31, 2008

36.2.8 A means for deactivating (silencing) activated alarm, predischarge, or discharge notification appliances shall comply with the following requirements:

a) Deactivating of activated notification appliance devices of a system shall be indicated by a constantly displayed and identified visual indicator.

b) An alarm signal deactivating means left in the off-normal condition when there is no alarm shall activate an audible trouble signal until the means is restored to normal.

c) When any deactivating means of a multiple-circuit system is activated, there shall be an indication of the related deactivated circuit(s) or zone(s) by an identified lamp(s) or other visual annunciation, and operation of the alarm notification appliances by any other circuit having its alarm deactivation means in the normal position shall not be prevented.

d) The switch shall be either:

1) A key-lock type with the key removable only in the normal position;

2) Located inside of a locked enclosure;

3) Access limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

e) The activation of the alarm, predischarge, or discharge signal deactivation means during an alarm or release condition shall not result in resetting a circuit intended for connection to releasing devices or HVAC equipment.

f) The alarm, predischarge, or discharge condition is indicated and maintained by a lamp or other visual indicator with the silencing means activated.

g) When signal deactivation can be accomplished in a selective or zone manner, the visual indicator(s) referenced in (a) shall distinguish notification appliance circuit(s) or zone(s) which have been deactivated from notification appliance circuit(s) or zone(s) which are still energized.

36.2.8 (a) effective December 31, 2008

36.2.9 An alarm, predischarge (unless the system has progressed to a discharge condition) and discharge signal of a system shall be maintained continuously (locked in) by the system until a resetting device in the system is operated manually.

36.2.10 The signal indication resulting from the operation of a product for supervisory signals shall automatically include distinctive signals for both the off-normal and the restoration-to-normal conditions of the supervisory initiating devices. Cancellation of the off-normal signal is acceptable annunciation for the restoration signal.

Exception: For products whose operation provide, in addition to the above, the capability of selecting nonautomatic distinctive restoration-to-normal supervisory signals (locking in the supervisory signals until manually reset), the installation wiring diagram/instructions for the product shall include instructions for selecting the respective operation.

36.2.10 effective December 31, 2008

36.2.11 Supervisory signals displayed at the system shall be distinctive in sound from other signals used by the signaling system and this sound shall not be used for any other purpose other than to also indicate a system trouble condition. When the same sound is used for both supervisory and trouble signals, distinction between signals shall be indicated by a visible means and silencing of a trouble signal shall not prevent subsequent sounding of supervisory signals.

36.2.12 A means for silencing a supervisory signal sounding appliance shall comply with all the following requirements:

a) Limiting access by being either:

1) Key operated with the key removable only in the normal position;

2) Located within a locked cabinet;

3) Limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

b) The supervisory condition is indicated and maintained by a lamp or other visual indicator.

c) Subsequent supervisory signals in other zones will reenergize the supervisory signal notification appliance(s).

d) A means that is left in the ″silence″ position, when there is no supervisory off-normal signal, shall cause the audible trouble signal to sound until the means is restored to normal.

36.3 Abort

36.3.1 An abort switch, when provided, shall be a manually-operated, self-restoring device that suspends the intended sequence leading to release of the extinguishing agent. Such a switch shall be marked "abort".

Exception: Abort switches shall not be used on systems intended to perform pre-action or deluge water functions.

36.3.1 effective December 31, 2008

36.3.2 An abort switch shall not have any effect on evacuation signals from the system, nor shall it cause confusing signals to be transmitted to a supervising station.

36.3.3 An abort switch shall not cause the restoration to normal of any initiating and notification appliance that has operated, nor shall it cause interference with any function of system, other than the interruption of the normal sequence leading to activation of the connected release actuating devices.

36.3.4 A system employing an abort function shall, at a minimum, have the capability of providing a time delay preventing the immediate actuation of the releasing device(s). The time delay function shall have a minimum capability to operate as follows:

a) The time delay does not exceed 60 seconds from the actuation of the abort switch.

b) The time delay overrides the automatic time delay described in 36.1.7.

c) Cumulative time delays, resulting from the operation of two or more abort switches connected into the same releasing device zone, shall not exceed 60 seconds.

Exception: The actuation of the releasing device can be delayed for as long as the abort switch is activated, when deactivation of the switch results in actuation of the releasing device within 10 seconds when the 60-second delay period has elapsed.

36.3.5 A circuit to which an abort switch is connected shall comply with the requirements for initiating-device circuits as described in Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51.

36.3.5 effective December 31, 2008

36.3.6 Actuation of an abort switch during normal supervisory condition shall result in an audible and visual annunciation at the operator interface of the system.

36.3.7 Operation of an abort switch while the system is in the alarm condition shall result in a distinct visual and audible annunciation of the abort condition at the operator interface for the system.

36.3.7 effective December 31, 2008

36.4 Manual release switch

36.4.1 When provided, a manual release switch shall be a manually-operated device (either self-restoring or nonself-restoring) that overrides time delays leading to the actuation of the releasing device(s). Such a switch shall be marked ″Manual Release″ or the equivalent.

36.4.2 The manual release switch shall override any pre-discharge delays resulting in an immediate release or start of the manual release delay period. The delay period shall be 30 seconds or less from activation of the switch to actuation of the releasing device(s). The manual release switch is not required to override an abort function while the abort switch is activated. The operating instructions for the control unit shall describe whether the operation of the manual release will override an activated abort switch.

36.4.2 effective December 31, 2008

36.4.3 The circuit into which a remote manual release switch is connected shall comply with the requirements for initiating-device circuits as described in Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51.

36.5 Cross-zone initiation

36.5.1 A system employing a cross-zone initiating function shall require an alarm condition on more than one initiating zone before the release condition is activated.

36.5.2 Actuation of one initiating-device circuit shall result in energization of intended alarm evacuation signals.

36.5.3 A system employing a cross-zone initiating function shall not utilize the alarm verification feature or any other time delay other than that indicated in 36.1.7.

36.6 Single-zone multiple-detector (counting zone) initiation

36.6.1 A system employing single-zone, multiple-detector initiating functions shall require more than one detector in the same initiating circuit to operate before the release condition is activated.

36.6.2 Operation of one detector connected to a single-zone multiple-detector initiating zone shall result in energization of intended alarm evacuation signals.

36.6.3 A system employing a single-zone multiple detector initiation function shall not utilize the alarm verification feature or any other time delay other than that indicated in 36.1.7.

36.7 Combination single-zone multiple-detector and cross-zone initiation

36.7.1 When a multiple-detector/cross-zoning configuration is employed, the operation shall comply with any combination of 36.5.1 – 36.5.3 and 36.6.1 – 36.6.3.

36.7.2 Operation of one initiating device shall result in energization of intended alarm evacuation signals.

REMOTE STATION, CENTRAL STATION, AND PROPRIETARY SERVICES

37 General

37.1 Sections 37 – 40 cover the requirements for products intended for remote station, central station, and proprietary services. Sections 37 and 38 cover products located at the protected premises. Sections 37, 39, and 40 cover the transmission path between the protected premises and the supervising station or subsidiary station, any subsidiary station and its communication path, and the signal receiving, processing, display, and recording equipment at the supervising station. When the supervising or subsidiary station is integral or collocated at the protected premises with the protected-premises control unit, Sections 37, 39, and 40 apply.

37.2 The product shall comply with the following:

a) Power Supplies, Section 50;

b) Component – Monitoring for Integrity, Section 53;

c) Software, Section 54; and

d) Combination Systems, Section 56.

37.3 The operation of any initiating device shall cause the system to produce a clearly defined signal of the type for which the combination is designed.

38 Protected Premises Units

38.1 General

38.1.1 The product shall comply with the following:

a) Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51;

b) Trouble Signals, Section 52;

c) Features, Section 55; and

d) Interconnected Fire Alarm Units, Section 57.

38.1.2 The time periods for processing and activation of signals in a worst-case loaded system shall be as follows:

a) Automatic processing of alarm or supervisory signals and start of transmission to a supervisory station receiver shall not be greater than 10 seconds from the initiation of an alarm or supervisory condition.

b) Transmission of trouble signals and their restoration to normal shall be started within 200 seconds of the occurrence of the adverse condition, fault, or the restoration to normal. Annunciation of trouble signals at the protected premises shall also occur within 200 seconds of the occurrence of the faults indicated in 38.2.1.

Exception No. 1: Trouble signals identifying an inoperative transmitter in a low-power radio-frequency system that comply with the Exception to 51.5.8.

Exception No. 2: The initial battery trouble signal from a battery-operated low-power radio-frequency transmitter complying with the requirements of 50.4.1.

Exception No. 3: Off-premises primary power failure trouble signal transmission for products employing digital alarm communication (DACT) transmission as described in 50.2.1.

Exception No. 4: Failure of DACT communication path as indicated in 40.3.2.12.

38.1.2 effective December 31, 2008

38.1.3 Alarm, supervisory, and trouble signals shall be indicated at the protected premises for systems serving two or more zones when the off-premises signal does not include zone of origin status change information. Where all zones or status changes are not displayed simultaneously, the display information shall comply with 33.2.2.

38.1.3 effective December 31, 2008

38.1.4 Alarm, supervisory, delinquency, and trouble status changes occurring at protected premises control unit(s) shall be transmitted to the supervising station in a manner that allows distinction of signaling type.

38.1.5 Each protected premises unit intended for remote station type service shall have provision for transmitting supervisory and trouble conditions to a separate location from that of alarm signals.

Exception: Provision for transmitting supervisory and trouble conditions to a separate location from that to which alarm signals are transmitted is not required to be provided when the control unit is prominently marked where visible after installation with the following or equivalent statement: "Not Suitable For Remote Station Protected Premises Service Where Separate Transmission Circuits Are Required For Fire, Supervisory (When Applicable), And Trouble Signals."

38.2 Trouble signals

38.2.1 The activation of a self-restoring trouble signal and its restoration to normal shall be automatically processed as described in 38.1.2 and 38.2.3.

38.2.2 The activation of a latching trouble signal shall be automatically processed as described in 38.1.2 and 38.2.3. Restoration of a latching trouble signal shall be processed as described in 38.1.2 and 38.2.3 after activation of a manual reset.

38.2.3 An audible and visual trouble signal shall be annunciated at the protected premises for the occurrence of the following fault and/or adverse conditions:

a) Primary power, secondary power, and primary battery power source monitoring of the protected-premise equipment as required in Power Supplies, Section 50.

b) DACT-type communication system monitoring described in 40.3.2.6 and 40.3.2.12.

38.3 Supervisory signals

38.3.1 The signal indication resulting from the operation of a product for supervisory signals shall automatically include distinctive signals for both the off-normal and the restoration-to-normal conditions of the supervisory initiating devices. Cancellation of the off-normal signal is acceptable annunciation for the restoration signal.

Exception: For products whose operation provide, in addition to the above, the capability of selecting nonautomatic distinctive restoration-to-normal supervisory signals (locking in the supervisory signals until manually reset), the installation wiring diagram/instructions for the product shall include instructions for selecting the respective operation.

38.3.1 effective December 31, 2008

38.3.2 The activation of a smoke detector mounted in air distribution systems and used solely for closing dampers or equipment shutdown as described in the Standard for Installation of Air-Conditioning and Ventilating Systems, NFPA 90A, is not prohibited from annunciating a supervisory signal at the supervising station.

38.3.2 revised July 14, 2005

38.4 Guard tour supervisory signals

38.4.1 A system utilized for guard tour supervisory signals shall comply with either 38.4.2 or 38.4.3.

38.4.1 effective December 31, 2008

38.4.2 A non-exception reporting system shall operate with the following signals either manually or automatically recorded:

a) The operation of each station intended to transmit a signal.

b) Where intermediate stations that do not transmit a signal are employed in conjunction with stations that transmit a signal, a distinct signal shall indicate the beginning and end of each tour of a guard, and a station that transmits signals shall be provided at intervals not exceeding ten stations.

c) Intermediate stations that do not transmit a signal shall be capable of operation only in a fixed sequence.

38.4.2 effective December 31, 2008

38.4.3 An exception reporting system shall operate with the following signals either manually or automatically recorded. Delinquency signals shall additionally be visually and audibly annunciated.

a) The guard shall initiate a start signal. When a start signal is not transmitted at least once every 24 hours for systems during which tours are continuously conducted, a delinquency signal shall be annunciated.

b) A delinquency signal when a tour station is not actuated within 15 minutes after the predetermined actuation time.

c) A finish signal within a predetermined interval after each completed tour of the premises.

38.4.3 effective December 31, 2008

38.5 Off-premises signaling

38.5.1 The transmission and/or communication path shall operate as described for the specific type of transmission and/or communication path as specified in Transmission and Communication Paths, Section 40.

38.5.2 Relays or modules providing signaling for off-premises transmission of trouble signals shall be arranged to produce a trouble signal at the supervising station when all power to the relay or module is removed.

38.5.2 effective December 31, 2008

38.5.3 A multiple ground fault or short-circuit fault on conductors extending from a circuit intended for connection to limited energy cable, that would prevent required alarm operation, shall result in a trouble or alarm signal.

38.5.4 Digital alarm radio transmitters (DART) utilizing private signal transmission facilities and radio alarm transmitters (RAT) shall be arranged to check for the fault conditions specified in 51.1.1 and those indicated in (a) and (b) such that within 200 seconds of the occurrence of a fault condition either an audible trouble shall be annunciated at the protected premises or a trouble signal transmission shall have commenced.

a) Any external antennas and related connecting cable and

b) Interconnections between elements of the transmitting equipment located in separate enclosures.

38.5.4 effective December 31, 2008

38.5.5 Where the elements of the equipment described in 38.5.4 are physically separate, provision shall be made such that the interconnecting wiring or cabling is capable of being mechanically protected.

38.5.5 effective December 31, 2008

39 Supervising Station Units

39.1 General

39.1.1 The time periods for processing and activation of signals in a worst case loaded system shall be as follows:

a) Alarm, trouble and supervisory signals, and their restoration to normal, shall be received, displayed, and recorded at the supervising station consistent with the communication and transmission methods utilized. See Transmission and Communication Paths, Section 40.

b) The maximum time from the occurrence of a fault or adverse condition in any transmission and/or communication path or equipment, or the restoration of the fault or adverse condition to normal until it is displayed and recorded at the supervising station, shall be consistent with the communication and transmission methods utilized. See Transmission and Communication Paths, Section 40.

c) A fault or adverse condition on interconnecting wiring or malfunction of equipment located within the supervising or subsidiary station, which are required to be monitored for integrity, shall result in an audible and visual trouble annunciation at the constantly attended supervising station's operator interface within 200 seconds of the occurrence. Restoration to normal shall also be indicated within 200 seconds.

Exception No. 1: Either an audible or visual only trouble signal is acceptable for mechanisms that are part of the supervising station equipment.

Exception No. 2: Cancellation of the trouble signal is acceptable for the restoration signal for mechanisms that are part of the supervising station equipment.

Exception No. 3: The primary power source of constantly attended supervising station equipment when the fault condition is obvious to the operator on duty.

39.2 Display and recording

39.2.1 The supervising station shall have:

a) A recording device consisting of either printer or magnetic medium or other nonvolatile electronic memory capable of being viewed or printed and

b) Two additional means, one of which shall be an audible signal,

capable of indicating the receipt of a status change signal.

39.2.2 Status change signals shall include alarm, trouble, supervisory, and guard tour supervisory signals as well as their restoration to normal.

39.2.3 A supervising station providing the option of turning off the audible signal associated with each status change, shall provide a visual annunciation which is constantly displayed indicating the off-normal condition of the audible signal.

39.2.4 The following information shall be recorded and displayed for each status-change signal:

a) Identification of the type of signal to show whether it is an alarm, supervisory, guard tour supervisory, or trouble signal;

b) Identification of the status change to differentiate between the initiation of an alarm, supervisory, delinquency, or trouble, or a restoration or return to normal from one or more of these conditions; and

c) Identification of the point of origin of each status-change signal.

39.2.5 All status-change signals shall be automatically and permanently recorded and displayed in a form which will expedite prompt operator interpretation in accordance with any one of the following:

a) Where a visual display is used that automatically provides status-change information for each individual signal, including type and location of occurrence, any form of automatic recording is acceptable. The recorded information shall include the content described above. The visual display shall show status information content at all times, and shall be distinctly different after the operator has manually acknowledged each signal. Each visual status change shall also be accompanied by continuous operation of an audible indication that will alert the operator to a signal status change. The audible indication shall either cease or change in form upon acknowledgment. Failure to acknowledge a signal shall not prevent subsequent signals from being recorded.

b) When a visual display is not provided, signal content information shall be automatically recorded on duplicate permanent visual recording instruments. One recording instrument shall be used for recording all incoming signals, while the other printer shall be used for recording only alarm, supervisory, guard tour supervisory, and trouble signals. The receipt of each signal requiring operator attention shall be accompanied by an audible indication that shall persist until manually acknowledged. The acknowledgment shall be recorded. Failure to acknowledge a signal shall not prevent subsequent signals from being recorded. Restoration of the signaling device to its prior or normal condition shall be recorded.

c) When a visual display is used in conjunction with a single recording device, the signal content information and acknowledgment shall be both displayed and recorded. The method of recording and display or indication of received signals shall provide all of the following conditions:

1) Each incoming signal requiring action to be taken by the operator shall result in an audible signal and not less than two independent methods of identifying the type, condition, and location of the status change.

2) Each incoming signal shall be automatically recorded. The record shall provide the type of signal, condition, and location, in addition to the time and date the signal was received.

3) Failure to acknowledge or act upon an incoming signal shall not prevent subsequent signals from being received, indicated or displayed, and recorded.

4) Each incoming signal shall initiate an audible signal that persists until manually acknowledged.

5) When a single display that does not permit viewing of all received signals concurrently is used, the display shall either:

i) Retain each signal on the visual display until manually acknowledged (the display shall also indicate when additional signals are waiting to be displayed) or

ii) Sequentially display each received signal in a scrolling manner until each signal is manually acknowledged (each signal shall be displayed a minimum of 2 seconds and a maximum of 5 seconds during each scroll).

6) When concurrent signals are received, the signals shall be displayed either:

i) In the following descending order of priority:

a) Signals associated with life safety,

b) Signals associated with property safety,

c) Supervisory or associated life and/or property safety trouble signals, and

d) All other signals; or

ii) Pending types (fire alarm, fire trouble, fire supervisory, etc.) of signals are identified and displayed. Access to any of the specific type queues shall be provided. The signals within each specific type queue shall be displayed in order of receipt, with the oldest signal first.

7) When multiple status changes are received for the same point prior to operator acknowledgment, the system is not prohibited from displaying only the most recent change of status for that point, provided prior to acknowledgement of the current status,

all the subsequent status changes for that point since the last status change acknowledgment for that point are presented to the operator in a form that allows the prompt operator interpretation of the condition.

8) Means shall be provided for the operator to redisplay any alarm, supervisory, trouble, guard tour supervisory, or other signals which have been acknowledged but for which a restoration to normal signal has not been received.

Exception: Systems other than those intended for proprietary type service are not required to prioritize signals and are not required to have the means to redisplay acknowledged but not yet restored signals.

39.2.5 revised March 31, 2006

39.2.6 Silencing of an audible, status-change indication signal, which is common to several circuits, shall result in reenergization of the audible signal upon receipt of a subsequent status-change signal.

39.2.7 Where a visual indication is required in 39.2.3 to identify a status-change signal and location from which the signal originated, any one of the following or equivalent means is required.

a) Supervised single lamp circuit including a common lamp test switch;

b) Unsupervised reliable light-emitting diode (LED) including a common lamp test switch. Reliability data to be provided by manufacturer as specified in 53.2(c);

c) Unsupervised parallel lamp circuits (at least two lamps);

d) Unsupervised single lamp circuit with supplementary recording of type, condition, and location of signal received;

e) Two recorders;

f) Liquid-crystal display or equivalent with test means and one recorder;

g) Unsupervised single lamp circuit plus common alarm lamp plus a common lamp test switch; and

h) Monitor/CRT complying with the requirements in this standard.

39.2.8 In lieu of a common lamp test switch [see 39.2.7(a), (b), and (g)] an equivalent means to readily identify a burned out lamp shall be employed. A common lamp test switch shall be either common to all lamps or a particular group of lamps.

39.2.9 To facilitate the prompt receipt of fire alarm signals, when multiple simultaneous status changes of any type occur within the system, the product shall comply with either of the following requirements:

a) The system shall be able to record, within 90 seconds, as simultaneous status changes:

1) Not less than 50 status changes for systems of 500 or more initiating devices circuits or

2) Not less than 10 percent of the total number of initiating devices or initiating-device circuits connected, whichever number is smaller.

Exception: For one-way private-radio frequency systems, not less than twelve simultaneous status changes shall be recorded within 90 seconds.

b) The system shall record fire alarm signals at a rate not slower than one every 10 seconds when any number of status changes occur at any rate without loss of any signals.

Exception: Where fire alarm, supervisory signals, and their associated trouble signals are the only signals processed by a system, the rate of recording shall not be slower than one signal every 30 seconds.

39.2.10 Multiple operator interfaces for the same supervising station shall be arranged to provide segregation of signals or responsibilities for operator action regarding status-change signals.

39.2.10 effective December 31, 2008

39.2.11 When the supervising station equipment is duplicated with automatic switch over, the switch over shall be accomplished in not more than 30 seconds, without loss of any signals.

39.2.11 effective December 31, 2008

39.2.12 Trouble signals indicating the faults described in Component – Monitoring for Integrity, Section 53, and annunciated separately from the supervising station receiving unit's operator interface, shall comply with the requirements in Trouble Signals, Section 52.

39.3 Monitoring integrity

39.3.1 The requirements in 39.3.2 – 39.3.4 apply to circuits other than transmission and communication paths utilized by supervising and subsidiary station units.

39.3.2 All means of interconnecting equipment, devices, and appliances within the supervising or subsidiary station shall be monitored for integrity of the interconnecting conductors or equivalent path and shall meet the requirements of 39.1.1(c).

Exception No. 1: The circuit of an alarm notification appliance intended to be installed in the same room with the supervising station control unit, when the notification appliance circuit conductors are to be installed in conduit or have equivalent protection against mechanical injury.

Exception No. 2: The circuit of a printer in the supervising station is not required to be monitored for integrity regarding single open, single ground, wire-to-wire short faults, or printer malfunction.

Exception No. 3: Interconnecting wiring between a stationary computer and the computer's keyboard, video monitor, touch screen, or mouse type device are not required to be monitored for integrity when:

a) A complete open in the interconnecting cable is visually indicated so as to be obvious to the user or the open does not affect the required system operation except for loss of the faulted function and

b) The interconnecting cable(s) does not exceed 8 feet.

Exception No. 4: Supplementary circuits interconnecting supplementary devices are not required to be monitored for integrity when adverse conditions or wire-to-wire faults do not interfere in any manner with the display and recording of signals.

39.3.2 effective December 31, 2008

39.3.3 A supplementary-device circuit is considered to be a circuit provided for controlling a device, the operation of which is supplementary to the operation of the supervising station. Supplementary devices usually include additional printers, audible signaling appliances, pilot lamps, and the like applied so as to produce duplication of the required signals.

39.3.4 Circuits interconnected to the receiving unit which may control the operation of the receiving unit are not considered supplementary and such circuits and devices are to be investigated with regard to their suitability of application and service in connection with the design and performance of the overall system.

39.3.4 effective December 31, 2008

40 Transmission and Communication Paths

40.1 General

40.1.1 This section describes the requirements for the transmission path(s) between the protected premises and remote subsidiary or supervising station(s), and the communication path(s) between remote subsidiary station(s) and the supervising station.

40.1.2 Dual control, where utilized, shall provide for redundancy in the form of a standby circuit or other alternate means of transmitting signals over the primary trunk portion of the transmission path. The system shall have the capability of either using the same methods of signal transmission over separate routes, or employing different methods of signal transmission.

40.1.2 effective December 31, 2008

40.1.3 Dual control transmission equipment shall be monitored for integrity as follows:

a) When dedicated transmission equipment, which is available full time and whose use is limited to fire alarm signaling purposes, is utilized, a test signal shall be initiated and completed a minimum of once an hour.

b) When public-switched telephone network facilities are utilized, a test signal shall be initiated and completed a minimum of once every 24 hours.

40.1.3 effective December 31, 2008

40.1.4 A successful signal transmission sequence of any other type within the same required period is considered to comply with the intent of 40.1.3.

40.1.4 effective December 31, 2008

40.1.5 A single break or a single ground on any transmission or communication circuit shall not cause an alarm signal.

40.1.5 effective December 31, 2008

40.1.6 The utilization of a double loop or redundant conductors or circuits to avoid electrical supervision does not meet the intent of these requirements.

40.1.6 effective December 31, 2008

40.1.7 When redundant equipment is employed for signal receiving, transmitting, or processing switch over shall be accomplished in not more than 30 seconds with no loss of signals during this period. The switch over shall be displayed and recorded at the supervising station.

40.2 Active multiplex

40.2.1 Alarm, trouble, and supervisory signals, and their restoration to normal shall be received, displayed, and recorded at the supervising station in not greater than 90 seconds from the time they are transmitted from the protected premises.

40.2.2 The occurrence of a fault condition, as described in 40.2.3, either singly or in combination, on the transmission or communication path that prevents the transmission of any status-change signal shall be:

a) Automatically indicated and recorded at the supervising station. The display and record shall identify the affected portions of the system, including trunk, or leg, or both and

b) Shall not inhibit or delay receipt of change of status signals over any other paths except those that are intended to be dependent on the affected path. A fault condition on one leg facility shall not inhibit normal service on any other trunk or other leg facility.

40.2.3 A fault condition is defined as one of the following:

a) Single open,

b) Single ground,

c) Wire-to-wire short, or

d) Multi-frequency noise on the leg facility comprised of either a single frequency or multiple frequencies, which impairs intended operation of bridging networks, but which are isolated from the leg or secondary trunks by rejection through an isolating bridge.

40.2.4 Restoration of normal service to the affected portions of the system shall be automatically recorded and displayed at the supervising station. The first status change of any initiating circuit, or initiating device directly connected to a signaling circuit, or any combination that occurred at any of the affected protected premises units during the service interruption shall also be displayed and recorded.

40.2.5 Active multiplex systems shall be designated in the product installation wiring diagram/instructions based upon the transmission capability of the system under various fault conditions. The systems shall be designated as follows:

a) A Type 1 system shall have dual control as described in 40.1.2 – 40.1.4. A fault condition, either singly or in combination, on a trunk or leg facility shall not inhibit the transmission of signals from any other trunk or leg facility, except those normally dependent on the portion of the faulted transmission channel. A fault condition, either singly or in combination, on a leg facility shall not inhibit normal service on any trunk or other leg facility. When public switched telephone network facilities are employed, they shall be used only as the alternate path for transmitting signals, except for derived channel with no more than 32 leg facilities.

b) A Type 2 system shall operate as described for Type 1, except that dual control as described in 40.1.2 – 40.1.4 is not required.

c) A Type 3 system shall automatically indicate and record at the supervising station the occurrence of a fault condition, either singly or in combination, that interferes with the ability of the trunk or leg facility to transfer change of status signals from the protected premises to the supervising station.

40.2.6 While the system is operating under the maximum specified loading, the maximum end-to-end operating time from the occurrence of a fault or adverse condition in any trunk or leg facility until it is displayed and recorded at the supervising station shall not exceed 90 seconds for Type 1 and Type 2 systems and 200 seconds for Type 3 systems.

40.2.7 Derived channel signals shall not be affected by either the on-hook or off-hook operating conditions of the shared telephone equipment.

40.2.7 effective December 31, 2008

40.3 Digital alarm communicator transmitter (DACT)

40.3.1 General

40.3.1.1 All signals exchanged in a digital alarm communication system shall be by digital code or equivalent. Signal repetition, digital parity check, or some equivalent means of signal verification shall be used.

40.3.2 Digital alarm communicator transmitter (DACT)

40.3.2.1 A digital alarm communicator transmitter (DACT) shall have provision for seizing the telephone line (going off-hook) at the protected premises, disconnecting an outgoing or incoming telephone call, and preventing use of the telephone line for outgoing telephone calls until the signal transmission to a digital alarm communicator receiver (DACR) has been completed.

40.3.2.2 A DACT shall have provision for satisfactorily obtaining an available dial tone, dialing the number of the digital alarm communicator receiver, obtaining verification that the receiver is ready to receive signals, transmit the signal, and receive acknowledgment that the receiver has accepted that signal. In no event shall the time from going off-hook to on-hook exceed 90 seconds per attempt.

40.3.2.3 Concurrent status changes occurring at a DACT, shall be prioritized before the DACT goes off-hook and are transmitted to the digital alarm communicator receiver (DACR). The priority levels of signals shall be as follows:

a) Signals associated with life safety;

b) Signals associated with property safety;

c) Supervisory signals and trouble signals associated with life and property safety; and

d) All other signals.

40.3.2.4 A DACT shall have means to reset and retry if the first attempt to complete a signal transmission sequence is unsuccessful. Additional attempts shall be made until the signal transmission sequence has been completed to a minimum of five and a maximum of ten attempts. A failure to complete the sequence in conjunction with one status change condition shall not prevent subsequent attempts to transmit any other status changes.

40.3.2.5 The DACT shall have provision for calling a second digital communicator receiver number should the signal transmission sequence to the first called number be unsuccessful. See 40.3.2.4.

40.3.2.6 When the maximum number of attempts to complete the sequence is reached, an audible and visual indication of the failure shall be energized at the protected premises.

40.3.2.7 A DACT that provides both fire and security protected premises services is not prohibited from suppressing the audible indication required in 40.3.2.6 during the period when the burglary protection is completely armed.

40.3.2.8 A DACT shall have provision for two separate transmission paths. The DACT shall be capable of selecting the operable transmission path in the event of failure of the other.

Exception: Where a DACT is connected to a telephone line that is monitored for integrity so that the fault conditions indicated in 40.2.2 – 40.2.7 are annunciated within 200 seconds at the supervising station, a second transmission path is not required.

40.3.2.8 effective December 31, 2008

40.3.2.9 The primary transmission path shall be a telephone line connected to the public-switched network. The secondary transmission path shall be any of the following:

a) A second telephone line.

b) A one-way private-radio frequency alarm signaling system utilized in accordance with 40.5.1 – 40.5.11.

c) Public cellular telephone service.

d) A Digital Alarm Radio System (DARS) utilized in accordance with 40.3.4.1.

e) A transmission means complying with 40.7.1.

40.3.2.9 effective December 31, 2008

40.3.2.10 The first transmission attempt shall utilize the primary means of transmission.

Exception: Where the primary transmission path is known to have failed.

40.3.2.10 effective December 31, 2008

40.3.2.11 Simultaneous change of status reporting over both transmission paths is permitted when redundant signals are suppressed at the supervising station.

40.3.2.11 effective December 31, 2008

40.3.2.12 Failure of either of the transmission paths, due to a loss of line voltage, shall result in an audible and visual trouble signal at the protected premises and the transmission of a trouble signal to the associated digital alarm communicator receiver over the operable path. The transmission shall be initiated within 4 minutes of occurrence of the fault. When public cellular telephone service is used as the secondary transmission path, loss of cellular service shall be considered a transmission path failure.

40.3.2.12 effective December 31, 2008

40.3.2.13 A DACT shall automatically initiate and complete a test signal transmission sequence to its associated receiver at least once every 24 hours. Both transmission paths shall be tested at intervals not exceeding 24 hours. The test signal sent when the protected premises system is in the normal supervisory condition shall be distinctively different from the test signal sent when the protected premises system is in an abnormal or non-restored condition. Retransmission of the previously reported off-normal or non-restored conditions does not meet the intent of the test signals being distinctly different.

Exception No. 1: For public cellular telephone service, the test signal shall be initiated a minimum of once every month.

Exception No. 2: Where two telephone lines are employed, each telephone line shall be tested at alternating 24-hour intervals.

Exception No. 3: When a DACT has provisions for being programmed to call a telephone number that is call forwarded to the line of the DACR, the test frequency shall be reduced to at least once every 4 hours.

40.3.2.13 effective December 31, 2008

40.3.2.14 A successful signal transmission sequence of any other type within the same 24-hour period is considered to meet the intent of 40.3.2.13 when the product/system complies with all of the following:

a) The associated receiver is capable of automatically annunciating delinquencies.

b) Both transmission paths are used over the period.

Exception No. 1: Public cellular telephone service is used a minimum of once every month.

Exception No. 2: Where two telephone lines are employed, each telephone line is used at alternating intervals.

c) The protected premises equipment and/or transmitter are not in the off-normal condition.

40.3.2.14 effective December 31, 2008

40.3.3 Digital alarm communicator receiver (DACR)

40.3.3.1 Failure to receive a test signal from each associated DACT as specified in 40.3.2.13 shall be treated as a trouble signal and shall result in the automatic display and recording of such at the supervising station.

Exception: A DACR intended only for central station service is not required to automatically annunciate, display, and record delinquency signals when marking on the product or in the installation wiring diagram/instructions clearly indicate the need to manually track the signaling performance of each DACT and failure to receive a signal from a DACT over the applicable period is to be handled as a trouble signal.

40.3.3.2 Test signals indicating a normal supervisory condition at the protected premises need only be recorded rather than both recorded and displayed.

40.3.3.3 The DACR shall have provision for connection to at least two separate incoming telephone lines.

40.3.3.4 When the connection time to a DACT exceeds an average of 30 seconds, the installation wiring diagram/instructions shall provide specific guidelines for establishing loading or the unit shall automatically switch the signal to a separate line not included in the hunt group.

40.3.3.5 Failure of any transmission path connected to a DACR, that is due to loss of line voltage, shall result in a visual and audible trouble annunciation at the supervising station within 200 seconds.

40.3.3.5 revised July 14, 2005

40.3.4 Digital alarm radio systems (DARS)

40.3.4.1 Where private signal transmission facilities are utilized as the secondary channel of a DACT system, the DARS shall meet the requirements in 40.5.1 – 40.5.11 with the following exceptions:

a) Status-change signals occurring at a digital alarm radio transmitter (DART) need only be transmitted to the digital alarm radio receiver (DARR) over one radio-frequency path.

b) There shall be a minimum 90 percent probability of the DART successfully completing each transmission sequence. The parameters shall be evaluated while the system is operating under the maximum specified channel loading and with 25 digital alarm radio transmitters (DART) actively in alarm reporting to the same repeater(s) and receiver(s) on the same transmission path(s).

40.3.4.1 effective December 31, 2008

40.3.5 Digital alarm radio transmitter (DART)

40.3.5.1 Failure of the public switched network telephone line shall result in an audible and visual trouble signal as at the protected premises and the transmission of a trouble signal to the associated supervising station by means of the DART. The trouble annunciation and transmission shall be initiated within 4 minutes of occurrence of the fault.

40.3.5.1 effective December 31, 2008

40.3.5.2 In the event that any DACT signal transmission is unsuccessful, the change of status shall be transmitted by means of the DART. The DACT shall continue its normal transmission sequence as required by 40.3.2.4.

40.3.5.2 effective December 31, 2008

40.3.5.3 The DART transmission sequences shall be repeated a minimum of 5 times. The transmission may be terminated in less than 5 sequences if the DACT successfully completes its transmission to the DACR.

40.3.5.3 effective December 31, 2008

40.3.5.4 A DART shall automatically initiate and complete a test signal transmission sequence to its associated DARR at least once every 24 hours. The test signal sent when the protected premises system is in the normal supervisory condition shall be distinctly different from the test signal sent when the protected premises system is in an abnormal or nonrestored condition. Retransmission of previously reported off-normal or nonrestored conditions does not meet the intent of the test signals being distinctly different.

40.3.5.4 effective December 31, 2008

40.3.5.5 A successful signal transmission sequence of any other type within the same 24-hour period is considered to comply with the intent of 40.3.5.4, when the associated supervising station is capable of automatically annunciating 24-hour delinquencies and the protected premises equipment and/or transmitter are not in an off-normal condition.

40.3.5.5 effective December 31, 2008

40.3.6 Digital alarm radio receiver (DARR)

40.3.6.1 Failure to receive a test signal at least once every 24 hours from each associated DART as specified in 40.3.2.13 shall be treated as a trouble signal and shall result in the automatic display and recording of such at the supervising station.

Exception: A DARR intended only for central station service is not required to automatically annunciate, display, and record delinquency signals when marking on the product or in a user's manual clearly indicate the need to manually track the signaling performance of each DART and failure to receive a signal from a DART over a 24-hour period is to be handled as a trouble signal.

40.3.6.1 effective December 31, 2008

40.3.6.2 Test signals indicating a normal supervisory condition at the protected premises need only be recorded rather than both recorded and displayed.

40.3.6.2 effective December 31, 2008

40.4 Two-way private-radio frequency multiplex

40.4.1 The occurrence of an adverse condition to a communication or transmission path that interferes with the proper transmission or receipt of status change of signals at the supervising station:

a) Shall be automatically displayed and recorded at the supervising station. The display and recording shall identify the affected portions of the system, including trunk, or leg facility, or both and

b) Shall not inhibit or delay receipt of change of status signals over any other paths, except those that are intended to be dependent on the affected path.

40.4.1 effective December 31, 2008

40.4.2 The transmission and communication paths shall be supervised so that when the signal strength received at any receiver is below the minimum specified signal strength, the condition and affected portion of the system shall be displayed and recorded at the supervising station.

40.4.2 effective December 31, 2008

40.4.3 The occurrence of continuous radio-frequency noise in excess of the specified maximum ambient noise level or signal-to-noise ratio (see 81.2.1 – 81.2.4) on the radio-frequency path between a transmitter, repeater, or subsidiary/supervising station receiver for a continuous period of 20 seconds or more shall be automatically displayed and recorded at the supervising station. The display and recording shall identify the affected portions of the radio-frequency signaling system.

40.4.3 effective December 31, 2008

40.4.4 Restoration of normal service to the affected portions of the system shall be automatically recorded and indicated. The first status change of any initiating circuit, or initiating device directly connected to a signaling circuit, or any combination that occurred at any of the affected protected premises units during the service interruption shall also be displayed and recorded.

40.4.4 effective December 31, 2008

40.4.5 While the system is operating under the maximum specified loading, the time from beginning an alarm, supervisory, or trouble transmission until it is displayed and recorded at the supervising station shall not exceed 90 seconds.

40.4.5 effective December 31, 2008

40.4.6 Two-way radio-frequency multiplex systems shall be designated in the product installation wiring diagram/instructions based upon the transmission capability of the system under the following fault conditions.

a) Type 4 systems shall have redundant means of the transmission and/or communication paths between the protected premises and the supervising station, as well as redundant RF receivers at the supervising station. Malfunction of any of the equipment, other than the protected premises transponder, shall not interfere with the receipt of signals at the supervising station.

b) Type 5 systems will not employ redundant transmission and/or communication paths, or RF receivers at the supervising station.

40.4.6 effective December 31, 2008

40.4.7 While the system is operating under the maximum specified channel loading, the time from the occurrence of:

a) An adverse condition that will prevent the transmission of any change of status signal

b) The malfunction of any transmitting and receiving equipment, including transmitting and receiving antennas, and interconnecting cables, in the entire transmission path

until a trouble is displayed and recorded at the supervising station, shall not exceed 90 seconds. The display and recording shall identify the affected portions of the radio-frequency system.

40.4.7 effective December 31, 2008

40.5 One-way private-radio frequency

40.5.1 Status-change signals occurring at a protected premise shall be transmitted to the radio supervising station receiver over at least two independent one-way radio-frequency paths. The paths shall be one of the following:

a) Through at least two independently-powered, independently-operating, and separately-located radio repeaters, each of which shall relay the signal to the radio supervising station receiver or

b) Through at least one radio repeater, which shall relay the signal to the radio supervising station receiver, and also independently directed to the radio supervising station receiver.

40.5.1 effective December 31, 2008

40.5.2 One-way private-radio frequency systems shall be monitored to verify that at least two independent one-way radio frequency paths, as required in 40.5.1, are utilized for each radio transmitter during each 24-hour period. The occurrence of a failure to receive a signal by either path shall be automatically displayed and recorded at the supervising station. The information shall identify the radio transmitter, and the radio repeater/receiver(s) that did not receive the signal.

Exception: A one-way private-radio-frequency system intended only for central station service is not required to automatically annunciate, display, and record 24 hour delinquency signals when marking on the product or in a user's manual clearly indicate the need to manually track the signaling performance of each radio transmitter and failure to receive a signal from a radio transmitter over a 24-hour period is to be handled as a trouble signal.

40.5.2 effective December 31, 2008

40.5.3 A test signal sent when the protected premises system is in the normal supervisory condition shall be distinctly different from the test signal sent when the unprotected premises system in an abnormal or nonrestored condition. Retransmission of previously reported off-normal or nonrestored conditions does not meet the intent of the test signals being distinctly different.

40.5.3 effective December 31, 2008

40.5.4 A successful signal transmission sequence of any type within the 24-hour period is considered to comply with the intent of 40.5.2 when the associated supervising station is capable of automatically annunciating 24-hour delinquencies and the protected premises equipment and/or transmitter are not in an off-normal condition.

40.5.4 effective December 31, 2008

40.5.5 Acceptable test signals are not required to be displayed, but shall be recorded at the supervising station.

40.5.5 effective December 31, 2008

40.5.6 The occurrence of continuous radio-frequency noise in excess of the specified maximum ambient noise level or signal-to-noise ratio (see 81.2.1 – 81.2.4) on the radio-frequency path between a transmitter, repeater, or subsidiary/supervising station receiver for a continuous period of 20 seconds or more shall be automatically displayed and recorded at the supervising station. The display and recording shall identify the affected portions of the one-way radio-frequency signaling system.

40.5.6 effective December 31, 2008

40.5.7 The radio-frequency paths shall be supervised so that when the radio transmitter signal strength received at the radio repeater stations or subsidiary/supervising station receivers is below the minimum specified signal strength, the condition and affected portion of the system shall be displayed and recorded at the supervising station.

40.5.7 effective December 31, 2008

40.5.8 A one-way radio alarm system shall transmit change of status conditions to comply with the end-to-end time parameters specified in 80.8.4. A minimum of three transmission sequences shall occur in the first 30 seconds. The parameters shall be evaluated while the system is operating under the maximum specified channel loading and with 25 radio transmitters actively in alarm and reporting to the same repeater(s) and receiver(s) on the same transmission path(s).

40.5.8 effective December 31, 2008

40.5.9 The time period over which a single change of status is transmitted shall not exceed 7.5 minutes (450 seconds).

40.5.9 effective December 31, 2008

40.5.10 The malfunction of any transmitting and receiving equipment, including transmitting and receiving antennas, and interconnecting cables, in the entire transmission path shall be displayed and recorded within 200 seconds at the supervising station.

40.5.10 effective December 31, 2008

40.5.11 Radio transmitters at the protected premises shall be arranged to check all antennas and related connecting cable and interconnections between elements of the transmitting equipment located in separate enclosures, such that within 200 seconds of the occurrence of a fault condition either an audible and visual trouble shall be annunciated locally, or, when possible, a trouble signal shall be transmitted so that display and recording at the supervising station will occur within an additional 200 seconds.

40.5.11 effective December 31, 2008

40.5.12 One-way radio-frequency systems shall be designated in the product installation wiring diagram/instructions based upon the transmission capability of the system under various fault conditions. The systems shall be designated as follows:

a) A Type 6 system is not required to have more than one radio-frequency supervising station.

b) A Type 7 system shall use more than one radio-frequency supervising station. A fault condition on more than one repeater that results in any radio transmitters no longer being supervised shall be indicated and recorded at the affected supervising station.

40.5.12 effective December 31, 2008

40.6 Direct-connect non-coded systems

40.6.1 Alarm, trouble, and supervisory signals, and their restoration to normal, shall be received, displayed, and recorded at the supervising station in not greater than 90 seconds from the time they are transmitted from the protected premises.

40.6.2 The maximum time from the occurrence of a fault or adverse condition in any transmission and/or communication path or equipment, or the restoration of the fault or adverse condition to normal until it is displayed and recorded at the supervising station shall not exceed 200 seconds.

40.6.3 The transmission and/or communication path between the protected premises and the supervising station, except for circuits wholly within the protected premise or the supervising station shall operate for alarm and supervisory signals under either of the following conditions:

a) A system shall operate during the occurrence of a single break or a single ground fault. The circuit shall be self-adjusting in the event of the aforementioned fault and shall be self-restoring when the break or fault is corrected.

b) A system shall operate during a single ground fault. The circuit shall normally be isolated from ground except for a ground detecting means, which shall indicate the ground fault automatically and operate an audible trouble signal. The ground detecting means is not required when the presence of a second ground fault will be indicated by either an audible trouble signal or an alarm signal.

40.7 Other transmission technologies

40.7.1 Other transmission technologies that operate on principles different from the transmission technologies covered in 40.1.1 – 40.6.1 shall meet the requirements in the Other Technologies Transmission section in National Fire Alarm Code, NFPA 72, and any other requirement considered appropriate for the application.

40.7.1 effective December 31, 2008

AUXILIARY SERVICE

41 General

41.1 Sections 42 and 43 cover the operation requirements for products intended for auxiliary service. Protected Premises Unit, Section 42, covers products located at the protected premises. Supervising and Subsidiary Station Units, Section 43, covers products located at the supervising station or subsidiary station including the communication path, and the signal receiving, processing, display, and recording equipment.

42 Protected Premises Units

42.1 General

42.1.1 The product shall comply with the following requirements:

a) Power Supplies, Section 50;

b) Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51;

c) Trouble Signals, Section 52;

d) Components – Monitoring for Integrity, Section 53;

e) Software, Section 54;

f) In Features, Section 55: Alarm verification, 55.2.1 – 55.2.3; Automatic drift compensation and/or smoke detector sensing chamber supervision, 55.5.1 – 55.5.3; Calibrated detector sensitivity testing, 55.6.1 – 55.6.4;

g) Combination Systems, Section 56; and

h) Interconnected Fire Alarm Units, Section 57.

42.1.2 Alarm signal annunciation for protected premises units serving two or more zones, and trouble signals shall be indicated at the protected premises. Where all zones or status changes are not displayed simultaneously, the display information shall comply with 33.2.1 – 33.2.4.

42.1.2 effective December 31, 2008

42.1.3 The time periods for processing and activation of signals in a worst-case loaded system shall be as follows:

a) Automatic processing and activation of the master box or shunt circuit shall not be greater than 10 seconds from the initiation of an alarm condition.

b) Trouble signals and their restoration to normal shall be annunciated at the protected premises within 200 seconds of the occurrence of the adverse condition, fault, or the restoration to normal.

Exception No. 1: Trouble signals identifying an inoperative transmitter in a low-power radio-frequency system that meet the Exception to 51.5.8.

Exception No. 2: The initial battery trouble signal from a battery-operated low-power radio-frequency transmitter that complies with the requirements of 50.4.1.

42.1.3 effective December 31, 2008

42.2 Alarm signals

42.2.1 The operation of any initiating device shall cause the system to automatically activate the master box or shunt circuit.

42.2.2 An alarm signal of a control unit/system shall be maintained continuously (locked in) by the protected premises unit until a resetting device in the protected premises unit is operated manually.

42.3 Auxiliary signaling circuit

42.3.1 Interconnections between the auxiliary protected premises control unit and the local energy type box shall be monitored for single open and single ground faults such that a trouble signal shall be annunciated at the protected premises for the fault condition.

42.3.2 A trouble signal shall persist at the protected premises until an actuated local energy box is manually reset.

42.3.3 The shunt-type connections of an auxiliary protected premises control unit is not required to be monitored for integrity.

42.3.3 effective December 31, 2008

42.3.4 A trouble signal shall be annunciated at the protected premises when any portion of the system at the protected premises is placed in a bypass or test (disable) mode.

42.3.4 effective December 31, 2008

43 Supervising and Subsidiary Station Units

43.1 Transmission and communication paths and supervising and subsidiary station equipment intended for auxiliary service shall comply with the applicable requirements in this standard and in the Public Fire Alarm Reporting Systems chapter in National Fire Alarm Code, NFPA 72.

MARINE APPLICATIONS

44 General

44.1 All equipment forming the system shall be evaluated to the requirements in General, Section 44, and Signaling, Section 45. Products forming a part of a system shall be evaluated in conjunction with the complete system. In addition, products for marine use shall additionally be investigated to the requirements in Environmental Tests for Marine Applications, Section 85.

44.1 effective December 31, 2008

44.2 The product shall comply with the following:

a) Power Supplies, Section 50;

b) Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51;

c) Trouble Signals, Section 52;

d) Components – Monitoring for Integrity, Section 53;

e) Software, Section 54;

f) Features, Section 55;

g) Combination Systems, Section 56; and

h) Interconnected Fire Alarm Units, Section 57.

44.2 effective December 31, 2008

44.3 A means shall be provided to conduct a field test on each individual initiating zone circuit for alarm and trouble conditions.

44.3 effective December 31, 2008

44.4 A test means shall be provided for testing each individual initiating zone circuit for the presence of ground(s). The product(s) shall provide the capability of electrically isolating the fire alarm control system from the electrical system of the ship.

44.4 effective December 31, 2008

44.5 A means shall be provided for silencing energized audible notification appliances connected to the notification circuits, while maintaining the alarm signals from energized visual notification appliances.

44.5 effective December 31, 2008

44.6 Microprocessor- or computer-based systems, after complete loss of power, shall automatically operate on supply power resumption.

44.6 effective December 31, 2008

45 Signaling

45.1 General

45.1.1 The operation of any initiating device shall cause the system to produce a clearly defined signal of the type for which the combination is designed.

45.1.2 The time periods for processing and activation of signals in a worst-case loaded system shall be as follows:

a) Automatic processing and activation of the alarm or supervisory notification appliances shall not be greater than 10 seconds from the initiation of an alarm or supervisory condition.

b) Trouble signals and their restoration to normal shall be annunciated within 200 seconds of the occurrence of the adverse condition, fault, or the restoration to normal.

Exception No. 1: Trouble signals identifying an inoperative transmitter in a low-power radio-frequency system that complies with the Exception to 51.5.8.

Exception No. 2: The initial battery trouble signal from a battery-operated low-power radio-frequency transmitter that complies with the requirements in 50.4.1.

45.1.2 effective December 31, 2008

45.1.3 Alarm signals, supervisory signals, and trouble signals shall be indicated at the operator interface for the control unit.

45.1.4 Fire-alarm signals, supervisory signals, trouble signals, and other signals shall be distinctly annunciated.

45.2 Display information

45.2.1 Systems serving two or more zones shall visually identify the zone of origin of the status change.

45.2.2 The visual annunciation shall be capable of displaying all zones having a status change. Where all zones or status changes are not displayed simultaneously, all the following conditions apply:

a) The display shall indicate the initial status change for the highest priority type signal.

b) An indication for each type (alarm, trouble, supervisory) of active non-displayed status changes shall be continuously visible during any off-normal condition.

c) A visual indication showing deactivated notification appliance circuits as required by 45.3.2.

d) The non-displayed status changes shall be capable of being displayed only by manual operation(s).

e) The display controls shall not interfere with the normal operation of the unit.

f) When concurrent signals are received, they shall be indicated as follows in descending order of priority:

1) Signals associated with life safety;

2) Signals associated with property safety;

3) Supervisory signals and trouble signals associated with life and/or property safety;

4) All other signals.

45.2.2 effective December 31, 2008

45.2.3 Nonelectrical visual annunciation integral with a switch shall include obvious distinct indications for both the normal and off-normal position of the switch. Utilization of the switch position does not meet the intent of complying with this requirement.

45.3 Alarm signals

45.3.1 An alarm input signal shall automatically actuate alarm notification appliance circuits necessary for evacuation and/or relocation.

45.3.2 Any manual or automatic means for turning off (silencing) activated alarm notification appliances shall comply with the following requirements:

a) Alarm signal deactivating of activated notification appliances of a control unit/system shall be indicated by a constantly displayed and identified visual indicator.

b) An alarm signal deactivating means left in the off-normal condition when there is no alarm shall activate an audible trouble signal until the means is restored to normal.

c) When any alarm signal deactivating means of a multiple-circuit control unit/system is activated, there shall be an indication of the related deactivated notification circuit(s) or zone(s) by an identified lamp(s) or other visual annunciation, and operation of the alarm notification appliances by any other notification appliance circuit having its alarm deactivation means in the normal position shall not be prevented.

d) An alarm signal deactivation switch shall be either:

1) A key-lock type, with the key removable only in the normal position;

2) Located inside of a locked enclosure, with the key removable only in the locked position;

3) Access limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

e) The activation of the alarm signal deactivating means during an alarm condition shall not result in resetting any actuated circuit other than the notification appliance circuit(s) or zone(s) being deactivated.

f) The alarm condition shall be indicated and maintained by a lamp or other visual indicator with the deactivating means activated.

g) When alarm signal deactivation can be accomplished in a selective manner, the visual indicator(s) referenced in (a) shall distinguish notification appliance circuit(s) or zone(s) that have been deactivated from notification appliance circuit(s) or zone(s) that are still energized.

h) After deactivating notification appliance circuit(s) or zone(s) resulting from an alarm in one alarm initiating device circuit, addressable alarm initiating device circuit, or addressable fire alarm initiating device, a subsequent alarm in any other system fire alarm initiating device circuit, addressable alarm initiating device circuit, or addressable initiating device shall cause all previously activated notification appliance circuit(s) or zone(s) to reactivate.

Exception No. 1: When a system is intended to provide signaling service to two or more physically separated zones, reenergization of the notification appliance circuits only on a zone basis meets the intent of the requirement. Specifics covering installation constraints shall be clearly detailed in the control unit installation wiring diagram/instructions.

Exception No. 2: Systems are not prohibited from having provision to automatically disable reenergizing alarm notification circuits due to subsequent activation of other addressable smoke detectors of the same type located in the same room or space as the initial activated device. Specifics covering installation constraints shall be clearly detailed in the control unit installation wiring diagram/instructions.

45.3.2 (a) effective December 31, 2008

45.3.3 An alarm signal of a system shall be maintained continuously (locked in) by the system until a resetting device in the control unit/system is operated manually.

45.3.3 effective December 31, 2008

45.4 Supervisory signals

45.4.1 The signal indication resulting from the operation of a product for supervisory signals shall automatically include distinctive signals for both the off-normal and the restoration-to-normal conditions of the supervisory initiating devices. Cancellation of the off-normal signal is acceptable annunciation for the restoration signal.

Exception: For products whose operation provide, in addition to the above, the capability of selecting nonautomatic distinctive restoration-to-normal supervisory signals (locking in the supervisory signals until manually reset), the installation wiring diagram/instructions for the product shall include instructions for selecting the respective operation.

45.4.1 effective December 31, 2008

45.4.2 Supervisory signals displayed at the system shall be distinctive in sound from other signals used by the signaling system and this sound shall not be used for any other purpose other than to also indicate a system trouble condition. When the same sound is used for both supervisory and trouble signals, distinction between signals shall be indicated by a visible means and silencing of a trouble signal shall not prevent subsequent sounding of supervisory signals.

45.4.3 A means for silencing a supervisory signal sounding appliance shall be provided and shall comply with all the following requirements:

a) Limiting access by being:

1) Key operated with the key removable only in the normal position;

2) Located within a locked cabinet;

3) Limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

b) The supervisory condition is indicated and maintained by a lamp or other visual indicator.

c) A means that is left in the ″silence″ position when there is no supervisory off-normal signal shall operate a visual supervisory silence indicator and cause the audible trouble signal to sound until the means is restored to normal.

SMOKE-CONTROL APPLICATIONS

46 General

46.1 Sections 46 – 49 cover the performance requirements of control equipment intended to control the flow of smoke.

46.1 effective December 31, 2008

46.2 The product shall comply with the following:

a) Trouble Signals, Section 52;

b) Components – Monitoring for Integrity, Section 53; and

c) Software, Section 54.

d) Combination Systems, Section 56.

46.2 effective December 31, 2008

47 Power Supplies

47.1 A visual ″power on″ indication (visible after the product is installed) is to be present on all firefighter's smoke-control stations and/or operator interfaces used for smoke control. A unique character presentation on a display device meets the intent of this requirement.

47.1 effective December 31, 2008

47.2 A product intended only for smoke-control applications is not required to provide a secondary power source.

47.3 When a product is supplied by at least two independent power supplies (one primary and one secondary) or is supplied by primary battery(ies), the product shall comply with Power Supplies, Section 50.

48 Firefighter's Smoke-Control Station (FSCS)

48.1 Means shall be provided to indicate the complete status of the system in an easy to understand manner and, for manual override of an automatic smoke-control sequence, via a firefighter's smoke-control station (FSCS), which can be any of the following:

a) The local control panel;

b) The building's main control center;

c) A separate annunciator; or

d) The equivalent.

48.2 The controls used for the purpose of initiating a smoke-control sequence, manually overriding an automatic smoke-control sequence or control of the annunciation, shall be provided with a means of limited access, such as key-operated with the key removable only in the normal position, located within a locked cabinet, access limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity, or arranged to provide equivalent protection against unauthorized use.

48.3 The FSCS shall provide manual control of all components or zones in a smoke-control system, and shall have the highest priority over all other automatic or manual control equipment with the exception of electrical or personnel protection devices. The commands shall provide for on-auto-off or equivalent operation.

Exception No. 1: The controls for equipment only controlled from the FSCS are not required to employ an ″auto″ position.

Exception No. 2: FSCS fan control capability is not required to bypass hand-off-auto or start/stop switches located on motor controllers of nondedicated smoke control system fans where:

a) The use of such a motor controller switch to turn a fan on or off results in an off-normal indication at the FSCS and

b) The installation instructions stipulate such motor controllers are accessible only to authorized personnel.

48.4 A building diagram that clearly indicates the type and location of all smoke-control equipment (fans, dampers, etc., either individually or by zone), as well as the building areas affected shall either be part of the FSCS or on a separate drawing with instructions to mount adjacent to the FSCS.

48.5 The current status of smoke-control components, controlled by the FSCS either on an individual or zone basis, shall be visually indicated at the FSCS. Means shall be provided for positive feedback (or ″proof″) of fan operation, including all fans used for smoke control having capacities in excess of 2000 cubic feet per minute (57 m^3/minute), damper position where warranted by the complexity of the system, and/or smoke-control functions.

48.6 Provision shall be included on the FSCS for testing the visual indicators. The test means shall be self-restoring.

48.6 effective December 31, 2008

49 Operation

49.1 The recognition of a fire condition shall cause the system to activate the smoke control strategy for which the combination is designed.

49.2 The time periods for processing and activation of signals in a worst-case loaded system shall be as follows:

a) Automatic processing and beginning smoke-control strategies, shall not be greater than 10 seconds from the actuation of a manual command or initiation of a fire alarm condition.

b) Trouble signals and their restoration to normal shall be annunciated within 200 seconds of the occurrence of the adverse condition, fault, or the restoration to normal.

Exception No. 1: Trouble signals identifying an inoperative transmitter in a low-power radio-frequency system that complies with the Exception to 51.5.8.

Exception No. 2: The initial battery-trouble signal annunciation from a battery-operated low-power radio-frequency transmitter that complies with the requirements in 50.4.1.

c) The total response time for individual components to reach their desired state after the smoke-control system has commanded them to alter their existing state shall not exceed 60 seconds for fans, and 75 seconds for dampers.

49.2 effective December 31, 2008

49.3 Where the fire alarm control unit is separate from the smoke control system, the interconnecting wiring shall be monitored for integrity in accordance with the Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51. Audible and visual trouble signals shall be indicated at the FSCS. See Figure 49.1.

Exception No. 1: Monitoring is not required when the installation instructions indicate that the wiring connection are to be made within 20 feet (6.1 m) and are to be enclosed in conduit (or equivalently protected against mechanical injury).

Exception No. 2: Ground-fault annunciation is not required where normal operation is not affected by a single ground-fault.

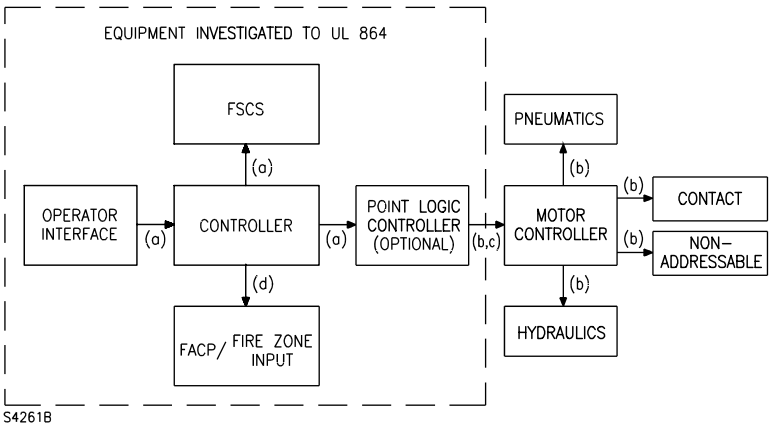
49.3 effective December 31, 2008

49.4 Interconnecting wiring between the FSCS, addressable controllers, transponders, point logic controllers, and operator interfaces intended to control smoke-control functions shall be monitored for integrity in accordance with the Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51. Audible and visual trouble annunciation shall be indicated at the FSCS and, when employed, operator interface(s). See Figure 49.1.

Exception: Ground-fault annunciation is not required where operation is not affected by a single ground fault.

Figure 49.1
Typical smoke-control system

Figure 49.1 effective December 31, 2008



NOTES:

(a) Monitored as specified in 49.4.

(b) Monitored as specified in 49.6 and 49.7.

(c) Non-addressable output such as 0 – 10 V, 4 – 20 mA, contact closure, etc.

(d) Monitored as specified in 49.3.

49.5 Output circuits of controllers and transponders that are pneumatic, hydraulic, dry-contact, or non-addressable are not required to be monitored as indicated in 49.4. The products controlled by these output circuits are required to comply with 49.6.

49.6 When the system is in the smoke-control condition, the failure of any fan, damper, and/or zone to reach its intended operating status shall result in both an audible and visual trouble signal at the FSCS. The visual annunciation shall indicate the specific component/zone that did not reach its intended operating status.

49.7 Dedicated smoke-control systems shall employ an automatic weekly self-test function. The self-test shall automatically command activation of each associated function. An audible and visual trouble signal shall be annunciated at the FSCS identifying any function that fails to operate within the required time period. The self-test function is not required for non-dedicated systems.

49.8 When multiple input signals are received from more than one smoke zone to initiate different automatic smoke-control sequence(s), the smoke-control system shall continue automatic operation in the mode determined by the first signal received.

49.9 The smoke-control system shall not activate an automatic smoke-control sequence as a result of a signal input generated by the activation of a manual pull station.

Exception: A smoke-control sequence for stairwell pressurization or other application where the sequence is the same for any input signal received.

49.10 The following descending order of priority shall be followed in processing smoke-control commands:

a) Manual activation and deactivation commands issued at the FSCS.

b) Manual activation and deactivation commands at other than the FSCS.

c) Initial automatically actuated smoke-control sequence. The system does not need to override any manual activation or deactivation functions in place prior to the automatic control sequence.

d) All other manual or automatic operation used for normal building operation.

COMMON REQUIREMENTS

50 Power Supplies

50.1 General

50.1.1 Each product shall be supplied by at least two independent power sources (one primary and one secondary), each of which is able to separately power the product.

Exception No. 1: Low-power radio transmitters complying with 50.4.1 are not prohibited from using a primary battery as the sole source of power.

Exception No. 2: Products deriving power from separate equipment complying with the Standard for Power Supplies for Fire Protective Signaling Systems, UL 1481, and which are supplied by at least two independent power sources.

50.1.1 effective December 31, 2008

50.1.2 The interruption and restoration of any source of electrical energy connected to a product shall not cause an alarm signal.

50.1.3 Transfer of the operating power to the secondary power source or return to the primary operating power source shall not cause the loss of any off-normal signaling condition.

50.1.4 A visual “power-on” indication, visible after the product is installed, is to be present on all products employing an operator interface. A unique character presentation on a display device meets the intent of this requirement.

50.1.4 effective December 31, 2008

50.2 Primary power source

50.2.1 All primary power source(s) shall be monitored for the presence of voltage at the point of connection to the product such that, after reaching the voltages specified in 50.2.3, the following shall occur:

a) An audible and visual trouble signal shall be annunciated at the protected premise for all products located at a protected premises, other than that equipment intended solely for use as remote station, central station, or proprietary protected premises units;

b) A trouble signal shall be transmitted for remote station, central station, and proprietary-type protected premises units after a delay of between 60 and 180 minutes.

Exception: Products are not prohibited from providing capability of selecting that the primary power failure trouble signal transmission be delayed other time periods, including no delay, provided the 60 – 180 minute delay is also included.

c) Either an audible- or visual-only trouble signal, or both, shall be annunciated at the supervising station for supervising station equipment.

Exception: The primary power source of constantly attended supervising-station equipment, when the fault condition is obvious to the operator on duty.

50.2.1 effective December 31, 2008

50.2.2 The requirement of 50.2.1 does not apply to the following circuits:

a) A power supply for supplementary equipment.

b) The neutral of a three-, four-, or five-wire AC or DC supply source.

50.2.2 effective December 31, 2008

50.2.3 Operating power of the product shall automatically be transferred to the secondary power source within 10 seconds without required signals being lost, interrupted, or delayed by more than 10 seconds and while maintaining compatibility of connected equipment when each of the following conditions occur:

a) Total instantaneous loss of primary power

b) Degradation of primary power to the point of transfer to secondary power.

Transfer to the secondary power source shall not occur below 85 nor above 90 percent of rated voltage. Restoration of the primary operating source to a value of not more than 90 percent of rated voltage shall result in the transfer of product operation to the primary operating source within 30 minutes.

Exception No. 1: A lower transfer cutout voltage is not prohibited when operation of the product is not impaired and compatibility of connected appliances is maintained.

Exception No. 2: The transfer for equipment located at a supervising or subsidiary station shall occur within 60 seconds and required signals shall not be lost, interrupted, or delayed more than 90 seconds after occurrence of the indicated conditions.

50.2.3 effective December 31, 2008

50.2.4 For units employing a rechargeable battery as the secondary power source, that does not utilize a transfer cutout scheme (such as a float-type battery charger), the trouble indication required by 50.2.1 shall occur as described in 50.3.5.

50.2.4 effective December 31, 2008

50.2.5 For units employing an uninterruptible power source, a trouble signal shall be initiated when the uninterruptible power source system switches from the primary power source to the secondary power source.

50.3 Secondary power source(s)

50.3.1 All secondary power source(s), other than those used solely to sustain time and date functions or volatile memory, shall be monitored for the presence of voltage at the point of connection to the product such that loss of voltage shall result in:

a) The annunciation of an audible and visual trouble signal at the protected premise for any product located at the protected premises;

b) The transmission of an off-premises trouble signal for remote station, central station, and proprietary-type protected premises units; and

c) The annunciation of either an audible- or visual-only trouble signal, or both, at the supervising station for supervising-station equipment.

50.3.1 effective December 31, 2008

50.3.2 The system shall produce the same alarm, supervisory, and trouble operation signals and indications, excluding the alternating current (AC) power indicator, when powered solely from its secondary power source as when the product is connected to its primary power source.

Exception: Amplifiers for an emergency audio announcement and paging alarm system are not required to remain energized when they automatically reenergize for alarm and failure of an amplifier results in an audible trouble signal when an alarm is present on the system.

50.3.2 effective December 31, 2008

50.3.3 Standby batteries, other than those used solely to sustain time and date functions or volatile memory, shall be rechargeable.

50.3.3 effective December 31, 2008

50.3.4 Products employing rechargeable batteries as the secondary power source shall monitor the integrity of the battery-charging circuit.

50.3.4 effective December 31, 2008

50.3.5 With regard to 50.3.4, products employing voltage controlled charging methods shall initiate a trouble signal when the charging voltage decreases below the marked nominal rated battery voltage.

50.3.5 effective December 31, 2008

50.4 Primary batteries

50.4.1 A primary battery is not prohibited from being used as the sole source of power for a low-power radio transmitter when all of the following conditions are met:

a) The capacity of the primary battery shall be monitored for integrity. The battery shall be monitored while loaded by:

1) Transmission of the transmitter or

2) A load equivalent to the load imposed by transmission.

b) A required battery trouble status signal shall be transmitted to the receiver for a minimum of 7 days before the battery capacity of the transmitter has depleted to a level insufficient to maintain proper non-alarm operation of the transmitter. The battery trouble signal annunciation at the receiver/control unit is not prohibited from initially being delayed up to 4 hours. The battery trouble signal shall be retransmitted at intervals not exceeding four hours until the battery is replaced.

c) 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 (b) is reached.

d) Annunciation of the battery trouble status signal at the receiver/control unit shall be distinctly different from alarm, supervisory, tamper, and initiating circuit trouble signals. It shall consist of an audible and visual signal that shall identify the affected transmitter.

e) The audible trouble signal of the receiver/control unit is not prohibited from being silenceable when provided with an automatic feature to resound the signal at intervals not exceeding 4 hours.

f) The battery trouble status signal shall persist at the receiver/control unit until the depleted battery has been replaced.

g) Any mode of failure of a primary battery in an initiating device transmitter shall not affect any other initiating device transmitter.

h) Each transmitter serves only one initiating device and is individually identified at the receiver/control unit.

51 Common Performance and Monitoring for Integrity – Protected Premises Units/Systems

51.1 General

51.1.1 All means of interconnecting equipment, devices, and appliances shall be monitored for integrity of the interconnecting conductor(s) and/or equivalent path(s) so that the occurrence of a single ground, single open, or adverse condition shall automatically result in a trouble signal.

51.1.2 The requirement in 51.1.1 does not apply to the following circuits:

a) Trouble signal circuits;

b) Interconnection between equipment within a common enclosure;

c) A circuit for supplementary system components when a short-circuit, an open, or a ground fault in no way affects the normal operation of the control unit/system except for omission of the supplementary feature (when necessary to comply with the above requirement, overcurrent protective devices provided for supplementary circuit protection shall be non-interchangeable);

d) Conductors for ground detection, where a single ground does not prevent the required normal operation of the system;

e) A non-interfering shunt circuit, when a fault condition of the circuit wiring results only in the loss of the non-interfering feature operation; and

f) The circuit connections extended to additional fire alarm control unit equipment when these wiring connections are intended to be made within 20 feet (6.1 m) of each other and are enclosed within conduit or equivalently protected against mechanical injury.

51.1.3 The utilization of a double loop or redundant conductors or circuits to avoid electrical supervision is not acceptable.

51.1.3 effective December 31, 2008

51.1.4 A single break or a single ground on any circuit shall not cause an alarm signal.

Exception: A single open is not prohibited from resulting in an alarm condition for products intended only for marine applications.

51.1.4 effective December 31, 2008

51.1.5 The operation of a product shall not depend upon any ground connection, except for those required for connection to ground fault detection circuit(s).

51.1.6 A multiple ground fault or short-circuit fault on initiating device, notification appliance, and/or signaling-line circuit(s) intended for connection to limited-energy cable, that would prevent required alarm operation, shall result in a trouble signal or alarm signal.

51.2 Initiating-device circuits

51.2.1 Each initiating-device circuit shall be defined by class or style or both in the product installation wiring diagram/instructions consistent with the operation of the particular circuit during the specified fault conditions described in Table 51.1.

Exception: Initiating-device circuits of products intended only for marine application.

51.2.1 effective December 31, 2008

Table 51.1
Initiating-device circuits

Table 51.1 effective December 31, 2008

Class	**B**			**B**			**B**			**A**			**A**		
Style	**A**			**B**			**C**			**D**			**E[a]**		
Alarm signal (A), trouble signal (T), and alarm receipt capability during abnormal condition (ARC)	**Signal type[b,c] and alarm capability[d]**														
	A	**T**	**ARC**	**A**	**T**	**ARC**	**A**	**T**	**ARC**	**A**	**T**	**ARC**	**A**	**T**	**ARC**
Adverse fault condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Single open		X			X			X			X	X		X	X
2. Single ground		X			X	R		X	R		X	R		X	R
3. Wire-to-wire short	X			X				X		X				X	
4. Loss of carrier (if used)/channel interface								X						X	

[a] Style exceeds minimum requirements for Class A.

[b] A = ALARM signal.

[c] T = TROUBLE signal.

[d] ARC = ALARM RECEIPT CAPABILITY during abnormal condition.

R = Required capability.

X = Indication required.

NOTE – Reproduced in part from the 2002 National Fire Alarm Code, NFPA 72, copyright National Fire Protection Association, Quincy, MA 02269.

51.3 Notification appliance circuits

51.3.1 Each notification appliance circuit shall be defined by class or style or both in the product installation wiring diagram/instructions consistent with the operation of the particular circuit during the specified fault conditions specified in Table 51.2.

51.3.1 effective December 31, 2008

Table 51.2
Notification appliance circuits

Table 51.2 effective December 31, 2008

Class:	**B**		**B**		**B**		**A**	
Style:	**W**		**X**		**Y**		**Z**	
Trouble indication at protected premises (T) and alarm receipt capability during abnormal condition (A)	**T**	**A**	**T**	**A**	**T**	**A**	**T**	**A**
Adverse fault condition	1	2	3	4	5	6	7	8
1. Single open	X		X	R	X		X	R
2. Single ground	X		X		X	R	X	R
3. Wire-to-wire short	X		X		X		X	
R = Required capability. X = Indication required.								
NOTE – Reproduced from the 2002 National Fire Alarm Code, NFPA 72, copyright National Fire Protection Association, Quincy, MA 02269.								

51.3.2 A single break, single ground, or wire-to-wire short-circuit fault on the installation conductors of one alarm notification appliance circuit shall not affect the operation of any other alarm notification circuit.

51.3.2 effective December 31, 2008

51.3.3 Circuits intended for use with addressable notification appliances shall additionally meet the requirements in 51.4.3.

51.3.3 effective December 31, 2008

51.4 Signaling line circuits

51.4.1 Each signaling line circuit shall be defined by class or style or both in the product installation wiring diagram/instructions consistent with the operation of the particular circuit during the specified fault conditions specified in Table 51.3.

51.4.1 effective December 31, 2008

Table 51.3
Signaling line circuits

Table 51.3 effective December 31, 2008

Class	**B**			**B**			**A**			**B**			**B**		
Style	**0.5**			**1**			**2[a]**			**3**			**3.5**		
Signal type or alarm receipt capability	**A**	**T**	**C**	**A**	**T**	**C**	**A**	**T**	**C**	**A**	**T**	**C**	**A**	**T**	**C**
Abnormal condition	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1. Single open		X			X			X	R		X			X	
2. Single ground		X			X	R		X	R		X	R		X	
3. Wire-to-wire short									M		X			X	
4. Wire-to-wire short and open									M		X			X	
5. Wire-to-wire short and ground								X	M		X			X	
6. Open and ground								X	R		X			X	
7. Loss of carrier (when used)/ channel interface														X	
Class	**B**			**B**			**A**			**A**			**A**		
Style	**4**			**4.5**			**5[a]**			**6[a]**			**7[a]**		
Signal type or alarm receipt capability	**A**	**T**	**C**	**A**	**T**	**C**	**A**	**T**	**C**	**A**	**T**	**C**	**A**	**T**	**C**
Abnormal condition	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
1. Single open		X			X	R		X	R		X	R		X	R
2. Single ground		X	R		X			X	R		X	R		X	R
3. Wire-to-wire short		X			X			X			X			X	R
4. Wire-to-wire short and open		X			X			X			X			X	
5. Wire-to-wire short and ground		X			X			X			X			X	
6. Open and ground		X			X			X			X	R		X	R
7. Loss of carrier (if used)/channel interface		X			X			X			X			X	

A = ALARM signal.
T = TROUBLE signal.
C = ALARM RECEIPT CAPABILITY during abnormal condition.
X = Indication required.

Table 51.3 Continued on Next Page

Table 51.3 Continued

Class	B			B			A			B			B		
Style	0.5			1			2[a]			3			3.5		
Signal type or alarm receipt capability	A	T	C	A	T	C	A	T	C	A	T	C	A	T	C
Abnormal condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R = Required capability.															
M = May be capable of alarm receipt with a wire-to-wire short.															
[a] Style exceeds minimum requirements for Class A.															
NOTE – Reproduced from the 2002 National Fire Alarm Code, NFPA 72, copyright National Fire Protection Association, Quincy, MA 02269.															

51.4.2 Where digital communications are used, the inability of a product to send or receive digital signals over a signaling line circuit shall result in a trouble signal.

51.4.2 effective December 31, 2008

51.4.3 A single break, single ground, or wire-to-wire fault on the installation conductors of a signaling line circuit for use with addressable notification appliances or modules shall not affect operation of more than one notification zone.

Exception: Riser conductors installed in accordance with the survivability from attack by fire requirements in National Fire Alarm Code, NFPA 72. Specifics covering the installation constraints shall be clearly detailed in the control unit's installation wiring diagram/instructions.

51.4.3 effective December 31, 2008

51.5 Low-power radio-frequency signaling

51.5.1 These requirements cover the operation of products and systems that utilize initiating, annunciating, and remote control devices that provide signaling by means of low-power radio-frequency (RF), with the transmitters operating on a random basis or using two-way interrogate/response signaling.

51.5.2 The requirements in 51.5.3 – 51.5.12 are based upon all required annunciation occurring at the receiver/control unit in a local application. When the receiver/control unit functions as a protected premises unit with off-premises signaling, the unit shall comply with all the local annunciation requirements in 51.5.3 – 51.5.12. In addition, as a minimum, a common alarm, supervisory, and trouble signal, as applicable, shall be transmitted to the supervising station. Where more specific signals are transmitted, such as zone or device information, only the initial change of status signal of each type for each zone or device shall be transmitted.

51.5.3 A primary battery shall comply with 50.4.1 when the primary battery is used as the sole power source of a low-power radio-frequency transmitter.

51.5.4 An alarm signal from a RF initiating device shall latch at the receiver/control unit until manually reset, and shall identify the particular RF initiating device in alarm.

51.5.5 When a receiver/control unit activates RF appliance(s) such as relays or notification appliances, the activated appliance shall remain locked-in until manually reset at the receiver/control unit.

51.5.5 effective December 31, 2008

51.5.6 A low-power radio-frequency system combination intended to provide supervisory service shall be arranged so that the occurrence of an off-normal condition of the supervisory device shall be annunciated by a supervisory signal and identify the affected device. The supervisory signal and affected device identification shall latch at the receiver/control unit until either manually reset or the restoration signal is processed as indicated in 51.5.7.

51.5.7 Restoration from off-normal to the normal supervisory condition of the supervisory device shall result in the receiver/control unit either canceling the previously annunciated supervisory signal or annunciating the status change audibly and visibly identifying the affected device.

51.5.7 effective December 31, 2008

51.5.8 To provide higher priority to alarm and supervisory signals than to other signals, alarm and supervisory signals shall be periodically repeated at intervals not exceeding 60 seconds until the initiating device is returned to its non-alarm condition. Receiver/control units activating RF appliances shall automatically repeat alarm and supervisory signal transmissions at intervals not exceeding 60 seconds or until confirmation that the output appliance received the signal. The duty cycle of the transmission shall be not more than 15 percent measured over a one-minute interval.

51.5.9 A receiver/control unit shall report and identify an inoperative transmitter in the system within 200 seconds.

Exception: When Federal Communications Commission (FCC) regulations limit supervision transmissions to not more than once per hour for a maximum of 1 second, the time period is not prohibited from being increased to 4 hours maximum when both of the following conditions are met:

a) Each transmitter serves a single initiating device and

b) When disabling of a single repeater (where employed) or its transmission does not prevent the receipt of signals at the receiver/control unit from any initiating device transmitter.

51.5.10 Additional assurance of successful transmission capability shall be provided by one of the following methods:

a) Transmitting the normal supervisory status transmission at a reduced power level of at least 3 decibels;

b) Either increasing the minimum signal strength or reducing the maximum ambient radio-frequency noise levels used in the product-specific field test procedure by at least 3 decibels;

c) Increasing the minimum signal to noise ratio used in the product-specific field test procedure by the equivalent of at least 3 decibels; or

d) By another equivalent means.

51.5.10 effective December 31, 2008

51.5.11 The audible tamper signal of the receiver/control unit is not prohibited from being silenceable when provided with an automatic feature to resound the signal at intervals not exceeding 4 hours. Both of the following actions shall cause the annunciation of a tamper signal at the receiver/control unit additionally identifying the affected device within 200 seconds.

a) Removal of an initiating-device transmitter, RF appliance receiver or retransmission device from its installed location, including displacement of a removable surface such as a ceiling tile.

b) Removal of a cover exposing a transmitter primary battery.

51.5.11 effective December 31, 2008

51.5.12 Reception of any unwanted (interfering) transmission by a retransmission device (repeater), or by the receiver/control unit that exceed the maximum specified ambient noise level or minimum signal-to-noise ratio (see 79.2.1 and 79.2.2) for a continuous period of 20 seconds or more shall result in an audible trouble signal indication at the receiver/control unit. This indication shall identify the specific trouble condition (interfering signal) as well as the device(s) affected (repeater and/or receiver/control unit).

51.5.12 effective December 31, 2008

51.6 Remote keypads/annunciators

51.6.1 Remote (but not supplementary) annunciators and keypads shall comply with the requirements in 51.1.1. Any required local trouble annunciation signal shall be audible at the primary operator interface.

51.6.1 effective December 31, 2008

51.6.2 A manually-activated alarm signaling switch integral with the keypad that complies with the Standard for Manual Signaling Boxes for Fire Alarm Systems, UL 38, shall be considered an initiating device.

51.6.2 effective December 31, 2008

51.6.3 Manual fire alarm activation at the keypad is permitted when:

a) The activation cannot occur inadvertently (such as by leaning up against the keypad or other similar-type action) and

b) The operation is not intended to be used in lieu of a manually-activated box.

51.6.3 effective December 31, 2008

51.6.4 When multiple circuits for keypads or annunciators are employed, the faults described in 51.6.1 shall be applied independently to each circuit.

51.6.4 effective December 31, 2008

51.6.5 When the keypad or annunciator is intended to operate as a supplementary device, the requirements of 51.1.2(c) apply.

51.6.5 effective December 31, 2008

52 Trouble Signals

52.1 A trouble signal shall be indicated by the operation of a distinctive sounding appliance. When an intermittent signal is used, it shall sound at least once every ten seconds with a minimum on-time duration of one-half second. When a common audible signal (distinct from alarm) is to be employed for trouble annunciation for both fire and non-fire related signals, distinction shall be achieved visually.

52.2 Cancellation of the off-normal signal is acceptable annunciation for a trouble restoration signal.

Exception: Trouble signals specified in 38.2.

52.3 The activation of a self-restoring trouble signal and its restoration to normal shall be automatically indicated as described in 52.1 and 52.2.

52.4 The activation of a latching trouble signal shall be automatically indicated as described in 52.1. Restoration of a latching trouble signal shall be indicated as described in 52.1 and 52.2 after activation of a manual reset.

52.5 A means for silencing a trouble sounding device shall comply with all of the following:

a) Limiting access by being either:

1) Key operated with the key removable only in the normal position;

2) Located within a locked cabinet;

3) Limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

b) A visible trouble indicator remains activated or is simultaneously activated when the sounding device is de-energized.

c) The audible trouble signal shall sound when the means is in the ″silence″ position and no trouble exists.

d) The visible indicator shall be located and identified so that the user will recognize the signal as soon as it is activated.

52.5 (a) effective December 31, 2008

52.6 An audible trouble signal that has been silenced at the protected premises shall

a) Automatically resound and remain energized until silenced and

b) Retransmit the trouble signal to any supervising station to which the original trouble signal was transmitted, as applicable,

at least once every 24 hours until the trouble condition is corrected and the product is restored to the normal supervisory condition.

Exception No. 1: Protected-premises units intended to signal off-premises are not prohibited from having provision to disable the automatic audible resound of the trouble signal at the protected premises.

Exception No. 2: The test signal transmission sequence described in 40.3.2.13 for DACT's; 40.3.5.4 for DART's; and 40.5.3 for one-way private radio systems meets the intent of sub-item (b) when the test signal transmission sequence and the initial trouble signal are transmitted to the same supervising station.

52.6 effective December 31, 2008

53 Components – Monitoring for Integrity

53.1 The fuses of a product shall be electrically supervised to indicate rupture of the fuse by an audible trouble signal when the fault prevents normal operation of the product.

Exception No. 1: Fuses protecting the primary input of smoke control equipment not utilizing a secondary power source.

Exception No. 2: Supplementary products where the fault in no way affects the normal operation of the system except for omission of supplementary features.

53.2 Opening or shorting of capacitors shall either have no adverse effect on normal operation or be indicated by a trouble or an audible alarm signal.

Exception: Where it is not practical to have a component failure indicated, a reliable component shall be used. The reliability of the component may be based on de-rating or on reliability data recorded for the particular component. Suitable sources are:

a) The capacitor derating parameters specified in Table 53.1;

b) The Military Handbook Electronic Reliability Design Handbook, MIL-HDBK-338; and

c) Component reliability data based on actual performance in a similar application, such that the failure rate is equal to or less than 0.5 failures per million hours of operation.

53.2 effective December 31, 2008

Table 53.1
Capacitor derating parameters

Type	Derating parameter	Derating level[a]
Mica, film, glass	Normal operating DC voltage	60 percent
	Temperature from maximum limit	10°C
Ceramic	Normal operating DC voltage	60 percent
	Temperature from maximum limit	10°C
Electrolytic aluminum	Normal operating DC voltage	80 percent
	Temperature from maximum limit	20°C
Electrolytic tantalum	Normal operating DC voltage	60 percent
	Temperature from maximum limit	20°C
Solid tantalum	Normal operating DC voltage	60 percent
	Maximum operating temperature	85°C

[a] Percent of derated value to the rated normal operating DC voltage.

53.3 Failure of a cooling fan motor which would result in product temperatures exceeding those in Tables 62.1 and 62.2 shall be indicated by an audible trouble signal.

Exception: Either an audible- or visual-only trouble signal at the operator interface is acceptable for mechanisms that are part of the supervising station equipment.

53.4 When the off-normal position of any normally preset mechanism or similar part of a product requires manual restoration in order to permit normal signaling performance of the system, such position shall be indicated by an audible trouble signal.

Exception: Either an audible- or visual-only trouble signal at the operator interface is acceptable for mechanisms that are part of the supervising station equipment.

53.5 The operation of any manual-switching part of a product to other than its normal or activated position while the system is in the normal supervisory condition shall be indicated by a trouble signal, when the off-normal position of the switch interferes with normal operation of the system.

Exception No. 1: Either an audible- or visual-only trouble signal at the operator interface is acceptable for mechanisms that are part of the supervising station equipment.

Exception No. 2: Operation of a disconnect switch or a disable function affecting the operation of a releasing circuit shall cause a supervisory signal.

Exception No. 2 of 53.5 effective December 31, 2008

53.6 To determine if a switching part of a product complies with 53.4 and 53.5, the investigation is to start with the representative system combination in the normal supervisory condition; the system is then to be operated for signals with the manual-switching part in each position.

53.7 When a product is controlled and influenced by a software program, a trouble signal shall activate for the occurrence of any of the following malfunctions:

a) The product/system does not execute its program cycle.

b) The memory function of the microprocessor does not function or is corrupted.

c) A power-supply output upon which the operation of the stored program relies (such as loss of power to a microprocessor, memory, disk supply, or the like) ceases to operate.

d) Rotation ceases, or fails to start when required, in a product that incorporates permanent memory-storage devices having rotating elements.

Exception: Supervision is not required when malfunction of the memory-storage device results only in loss of supplementary information or features, and when the system is still capable of indicating the nature and location of any status change.

53.7 effective December 31, 2008

53.8 A system shall not be affected if the system fails to execute any supplementary program.

53.9 Where an audible trouble signal is used to annunciate the conditions indicated in 53.1 – 53.7 for supervising station equipment, the trouble signals shall comply with the requirements in Trouble Signals, Section 52.

54 Software

54.1 General

54.1.1 Any product that is dependent upon software program(s) to achieve proper operation shall meet all the requirements in this section.

54.1.1 effective December 31, 2008

54.1.2 Where compliance with this standard is dependent upon the proper selection of software features and parameters which are field programmable, one of the following shall be met:

a) The software shall not permit any product operation or contain any programming options that are prohibited by this standard;

b) The software shall be partitioned and identified in the field programming software as complying or not complying with (a); or

c) A summary as described in 90.23 shall be provided in the front of the programming manual describing all programming options and parameters that have the potential for conflicting with the requirements in this standard and stating the proper program selections that would be in accordance with this standard. Additionally, information shall also appear throughout the manual where the specific feature or option appears describing the requirements of this standard.

54.1.2 effective December 31, 2008

54.1.3 A release level shall identify the executive software of a product. A new release level shall be assigned due to any changes in the executive software.

54.1.3 effective December 31, 2008

54.1.4 With the executive software resident in the product, the release level of the software shall be visibly marked on the product or shall be capable of being displayed on a visual annunciator provided as part of the unit.

54.1.4 effective December 31, 2008

54.1.5 All software shall be resident in nonvolatile storage devices that are sealed against atmospheric contaminants and not subject to mechanical wear of the storage medium. Integrated circuits and sealed hard disk drives are examples of storage devices that meet this requirement.

Exception: Software and data that is of a supplementary nature or software used to initially program the product.

54.1.5 effective December 31, 2008

54.1.6 Where the design of the product requires that status-change signals be stored in memory in order for the signal to be displayed by the control unit, the software shall have sufficient capacity to store not less than the following number of concurrent status changes:

a) Protected-premises unit – Total number of initiating-device circuits plus initiating devices connected to all signaling-line circuits up to a maximum of 10 or ten percent of the total, whichever is greater.

b) Supervising station unit – Ten percent of the total number of transmitters on all transmission channels up to a maximum of 500.

54.1.6 effective December 31, 2008

54.1.7 Where status-change signals are stored in memory and the memory capacity is not capable of storing all possible signals simultaneously, the software design shall prohibit the overflow condition causing corruption of existing stored data or causing the control unit to perform in a degraded mode with regard to the status changes which are stored in memory.

54.1.7 effective December 31, 2008

54.2 User access and programming

54.2.1 The executive program shall not be accessible for change, modification, or addition by the user, nor shall program execution depend upon site specific programming by the user.

54.2.1 effective December 31, 2008

54.2.2 Site-specific programming is not prohibited from being performed at the factory or in the field. When the product permits programming in the field, the extent of the programming shall be limited to the following:

a) Assignment and mapping of protected premises output circuits where there is a procedure or product feature that allows the programmer or AHJ to readily verify and review all programming. Mapping of input circuits to a supervising station transmitter output circuit is not permitted and shall be automatically accomplished by the executive program. Actuation of the supervising-station receiver output circuits (audible visual, recording) shall be automatically accomplished by the executive program without user input.

b) Setting of parameters and variables that relate only to topics influenced by use and installation of the product.

54.2.2 effective December 31, 2008

54.2.3 A security means shall be provided to restrict unauthorized access to site specific programming. The means shall provide a minimum of 1000 possible combinations. The security means shall not be the same as the access means provided to enable the products operational controls or features. The use of different passwords meets the intent of this requirement.

54.2.3 effective December 31, 2008

54.2.4 Initial site specific programming or any subsequent reprogramming of a protected-premises unit shall require manual actuation of the security means at the protected-premises unit. Once activated, programming may be completed on-site or downloaded from an off-site location.

Exception No. 1: For a proprietary system intended to protect only contiguous properties, program downloading from the supervising station without manual actuation at the protected-premises unit is permitted.

Exception No. 2: The telephone numbers associated with a DACT are permitted to be reprogrammed from an off-site location without manual actuation at the protected-premises unit.

54.2.4 effective December 31, 2008

54.2.5 When the proper operation of a product is adversely affected due to actuation of the security means or during any reprogramming, the product shall produce a visual trouble signal. In addition, a protected-premises unit connected to a supervising station receiver shall transmit a trouble signal.

54.2.5 effective December 31, 2008

54.3 Software integrity

54.3.1 The software design shall cause the product to operate as intended and shall not contain known critical defects which result in interruption of product operation, operation not intended by the design of the product, or which is inconsistent with the requirements of this standard.

54.3.1 effective December 31, 2008

54.3.2 With regard to 54.3.1, evidence of software integrity shall be any of the following:

a) The product complies with the Eighth edition of the UL 864 (titled Control Units for Fire-Protective Signaling Systems), with successful operation of the software for a period of one year or more.

b) Software development using a documented process, which includes the test procedures specified in 54.3.3 and which has been certified to meet the requirements of ISO 9001.

c) Examination of the software operation by the manufacturer with a test and verification program that is documented with a test plan and test results which, at a minimum, includes verification of the items specified in 54.3.3.

Documentation for (b) and (c) shall include a description of the test methods used, test result(s), and identification of test equipment.

54.3.2 effective December 31, 2008

54.3.3 The test program specified in 54.3.2 shall include performance-based testing of the functions described in (a) – (d).

a) Confirmation of proper operation of all circuits of each applicable type, style and class, verified as described.

1) Supervised initiating device circuits:

i) Subjecting the circuit to fault conditions (short, open, ground) and verifying that the condition is detected and the system responds as required.

ii) Verify the circuit will detect and respond to an alarm or, if applicable, supervisory condition, and that the system responds as required.

iii) Verify that the alarm verification cycle completes correctly.

2) Supervised output (notification appliance, master box, releasing, etc.) circuits:

i) Subjecting the circuit to fault conditions (short, open, ground) and verifying that the condition is detected and the system responds as required.

ii) Verify the circuit activates correctly when commanded by the system.

iii) Verify that the output signal is recognizable and complies with all timing requirements.

3) Communication and transmission circuits:

i) Subjecting the circuit to fault conditions (short, open, ground) and verifying that the condition is detected and the system responds as required.

ii) Verify that messages are transmitted correctly in response to system stimuli.

iii) Verify that incorrect messages are processed appropriately.

4) Signaling line circuits:

i) Subjecting the circuit to fault conditions (short, open, ground) and verifying that the condition is detected and the system responds as required.

ii) Verify that a minimum of at least 1 message, per type, is transmitted correctly as required.

iii) Verify that incorrect messages are processed appropriately.

iv) Verify that mismatches between the actual devices on a circuit and the expected devices on a circuit are detected and reported correctly.

b) Confirmation of proper operation of visual annunciators and displays:

1) Verify that at least 1 event, per type, intended for the display and/or annunciator is successfully routed to and displayed by the display and/or annunciator.

2) Verify that events not intended for the display and/or annunciator are not displayed.

c) Confirmation of proper operation of manual controls:

1) Verify that all key presses are processed.

2) Verify that all key presses and menu selections generate the expected action.

3) Verify that incorrect entries are rejected and do not cause abnormal system operation.

d) Confirmation of proper operation of all programming options:

1) Verify that programming options cause the operation intended.

2) Verify that incorrect entries are processed appropriately.

e) Confirmation of proper operation of intelligent devices that are controlled by the panel:

1) Verify that the panel correctly controls the device as designed.

54.3.4 The testing information specified in 54.3.2 (b) and (c) shall be submitted for review for any new products and whenever functions are added to the software of an existing product.

54.3.4 effective December 31, 2008

55 Features

55.1 General

55.1.1 The features described in this section are optional. Any feature provided shall operate as described.

55.2 Alarm verification

55.2.1 To reduce the effect of electrical and migratory smoke transients, a system is not prohibited from having provision for an alarm verification feature for alarm signals received from smoke detectors or smoke monitoring heads. When employed, the feature shall be:

a) Integral in the control unit;

b) A module that can be wired or plugged into a control unit;

c) A separate product that can be field wired to interface between the control unit and initiating device circuit; or

d) An equivalent arrangement.

Alarm verification shall be arranged on a per circuit (zone) basis.

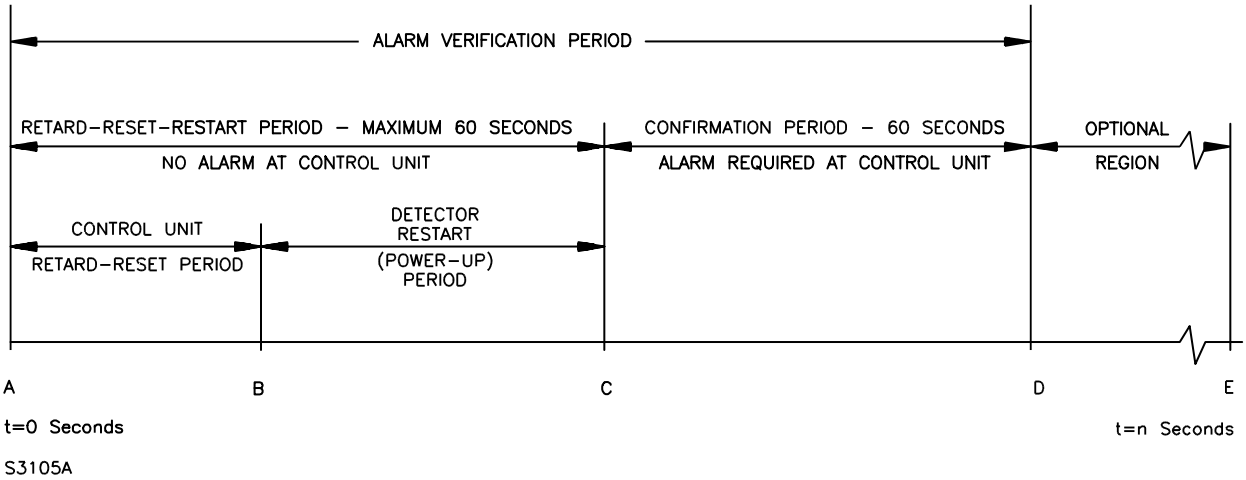
Exception: When alarm verification is to be accomplished on a multiple circuit (zone) or system basis, the retard-reset-restart period duration shall not exceed 30 seconds. Alarms from devices other than smoke detection shall not be delayed by more than 10 seconds when this option is employed.

55.2.1 effective December 31, 2008

55.2.2 When an alarm verification feature is provided, the maximum retard-reset-restart period of alarm verification of a system, including any time delay due to system reset and power-up time of the smoke detector to become operational for alarm, shall not exceed 60 seconds. During the minimum 60-second alarm confirmation period following the retard-reset-restart period, re-actuation of the same detector that initiated the alarm verification cycle, actuation of another smoke detector on the same circuit (zone), or an alarm from another zone shall result immediately in an alarm signal from the control unit. See Figure 55.1.

Exception: When two or more protected-premises units are connected to a supervising station unit or when two or more local-type control units are networked together, it is acceptable to configure each protected premises unit or local unit to permit its own alarm verification feature.

Figure 55.1
Alarm verification timing diagram



A – Smoke detector goes into alarm.
AB – RETARD-RESET PERIOD (Control Unit) – Control unit senses detector in alarm and retards (delays) alarm signal, usually by de-energizing power to the detector. Length of time varies with design.
AC – RETARD-RESET-RESTART PERIOD – No alarm obtained from control unit. Maximum permissible time is 60 seconds.
AD – ALARM VERIFICATION PERIOD – Consists of the retard-reset-restart and confirmation periods.
BC – DETECTOR RESTART (POWER UP) PERIOD – Power to the detector is reapplied and time is allowed for detector to become operational for alarm. Time varies with detector design.
CD – CONFIRMATION PERIOD – Detector is operational for alarm at point C. If detector is still in alarm at point C, control unit will alarm. If detector is not in alarm, system returns to standby. If the detector re-alarms at any time during the confirmation period the control unit will alarm.
DE – OPTIONAL REGION – Either an alarm can occur at control unit or restart of the alarm verification cycle can occur.

55.2.3 The retard-reset period of alarm verification is not required to include the polling time of a multiplex system when alarm verification is provided at the same unit to which the smoke detectors are connected, but shall include the polling time when the alarm verification is provided at a remote unit.

55.2.4 Alarm verification shall not be used in initiating-device circuits intended for cross-zone operation.

55.2.5 Products incorporating an alarm verification feature shall not be used with smoke detectors employing an alarm verification feature.

Exception: This requirement does not apply to smoke detectors that employ less than 10 seconds signal processing time and do not reset themselves.

55.2.6 Alarm verification shall apply to alarm signals from smoke detectors only, and not to alarm signals from other initiating devices (such as manual stations, heat detectors, water flow indicators, and similar devices) which are capable of being connected to the same circuit.

55.2.6 effective December 31, 2008

55.2.7 To determine the retard-reset duration of the alarm verification feature (not including the power-up time of a smoke detector), a product/control unit is to be connected to a rated source of electrical supply as specified in 30.1.2. Each initiating device circuit provided with alarm verification is to be placed into alarm by a switch representing detector contacts, by actuation of the specific detector to be employed with the product/control unit, or by equivalent means. The time between initiation of the detector alarm and energization of the product/control unit alarm circuit is the retard-reset period. The retard-reset-restart period is to be determined by adding the maximum power-up time of the smoke detector(s), intended to be connected to the product/control unit as indicated in the product/control unit installation wiring diagram/instructions, to the retard-reset period.

55.2.8 To determine that an alarm is obtained from the product during the 60-second minimum alarm confirmation period, the product/control unit and initiating device circuit are to be energized in the normal standby condition. The initiating device circuit is then to be placed in alarm to actuate the alarm verification cycle of the product/control unit and restored to the non-alarm condition. At the end of the alarm confirmation period, the initiating device circuit is to be placed in alarm at which time the product is to alarm.

55.3 Multiple detector operation

55.3.1 Alarm activation that requires the activation of two automatic detection devices shall not utilize the alarm verification feature or any other time delay.

55.3.1 effective December 31, 2008

55.3.2 Guidelines, instructions, and restrictions [such as spacing, alarm verification feature, and/or other time delay(s)] for the installation and use of a system employing multiple detector operation shall be included in the installation wiring diagram/instructions.

55.3.2 effective December 31, 2008

55.4 Positive alarm sequence

55.4.1 Positive alarm sequence shall be used only for alarm signals from automatic fire detection devices.

55.4.1 effective December 31, 2008

55.4.2 All system evacuation signals associated with the activated initiating device and any off-premises signaling shall be activated immediately and automatically when:

a) The alarm signal from an automatic fire detection device is not acknowledged within 15 seconds of annunciation at the operator interface of the system;

b) The system is not manually reset within 180 seconds of the acknowledgment described in (a);

c) When a second automatic fire detector selected for positive alarm sequence is actuated before the system is reset as described in (b); or

d) When any other fire initiating device reporting to the system/control unit is actuated.

55.4.2 effective December 31, 2008

55.4.3 The system shall provide a means for bypassing the positive alarm sequence.

55.4.3 effective December 31, 2008

55.5 Automatic drift compensation and/or smoke detector sensing chamber supervision

55.5.1 Where automatic drift compensation of sensitivity or chamber supervision for contamination of a smoke detector is provided, the system shall annunciate an audible and visual trouble condition, identifying the affected detector, when service is required. For automatic drift compensation, the trouble signal shall be activated when the limit of compensation is reached. For systems utilizing sensing chamber supervision, the trouble signal shall be activated before the chamber clean-air reference value changes by more than 50 percent of the shift necessary to indicate an alarm signal.

55.5.1 effective December 31, 2008

55.5.2 After automatic drift compensation has occurred, the sensitivity of the smoke detector shall be within 0.5 percent/Ft. obscuration of the initial sensitivity when tested as described in 61.5.4.1 – 61.5.4.4.

55.5.2 effective December 31, 2008

55.5.3 The compensation shall not adversely affect the operation of the smoke detector. The magnitude of each compensation step shall not change the clean-air reference value by more than 5 percent of the shift necessary to indicate an alarm signal. The summation of compensation steps over a twenty-four hour period shall not change the clean-air reference value by more than 50 percent of the shift necessary to indicate an alarm signal.

55.5.3 effective December 31, 2008

55.6 Calibrated detector sensitivity testing

55.6.1 The product/control unit shall correctly interpret the sensitivity of fire detectors and either display the sensitivity of each device upon command, or annunciate a trouble condition identifying the specific detector(s) that are not within their required sensitivity limits.

55.6.1 effective December 31, 2008

55.6.2 When initiated automatically, the specific or range of test interval(s) shall be indicated in the product/control unit's installation wiring diagram/instructions.

55.6.2 effective December 31, 2008

55.6.3 When the product/control unit displays the sensitivity in values other than percent/Ft obscuration, the correlated values to percent/Ft obscuration shall be either included in the product/control unit's marking or installation instructions.

55.6.3 effective December 31, 2008

55.6.4 Samples of the system shall be subjected to the confirmation testing described in 61.5.5.1 and 61.5.5.2.

55.6.4 effective December 31, 2008

55.7 Pre-signal

55.7.1 When a system annunciates the initial alarm signal only in a constantly attended location, and manual activation is required for a general alarm evacuation signal, subsequent actuation of alarm initiating devices on another initiating zone of the system shall result in the activation of the general alarm evacuation signal.

55.7.1 effective December 31, 2008

55.7.2 Any off-premises signaling, when employed, shall activate upon the initial alarm signal.

55.7.2 effective December 31, 2008

56 Combination Systems

56.1 When a fire alarm system shares components, equipment, circuitry, and installation wiring with non-fire systems, short circuits, open circuits, or grounds in the non-fire system equipment or the connections between the non-fire system equipment and the fire alarm products shall not impair the required operation of the fire alarm system or prevent appropriate alarm, supervisory, or trouble annunciation and signaling, or unfaulted fire-safety control activation.

56.1 effective December 31, 2008

56.2 To determine compliance with 56.1, the operation, removal, replacement, failure, or maintenance procedure on any hardware, software, or circuit not performing any of the fire alarm system functions shall not cause loss of any of the fire alarm functions, including supervision, or prevent required alarm, supervisory, trouble, or fire-safety annunciation, signaling, or actuation.

56.2 effective December 31, 2008

56.3 The monitoring for integrity as described in the Common Performance and Monitoring for Integrity – Protected-Premises Units/Systems, Section 51, shall continue to be met during the period the combination system is used for non-emergency purposes.

56.3 effective December 31, 2008

56.4 Fire safety or other non-fire functions shall not interfere with any required operation of the fire alarm system.

56.4 effective December 31, 2008

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

56.5 effective December 31, 2008

56.6 Where the fire alarm control unit is intended to be connected to a life safety network, the following shall apply:

a) The interconnecting path shall be monitored for integrity as described in the Common Performance and Monitoring for Integrity – Protected-Premises Units/Systems, Section 51.

Exception: Relays or appliances that provide fail-safe operation (activate, release, unlock) on loss of power or a fault or adverse condition on the interconnecting path that affects operation.

b) Non-fire alarm data transmitted to the fire alarm system shall not impair the operation of the fire alarm system.

56.6 effective December 31, 2008

57 Interconnected Fire Alarm Units

57.1 The interconnections of fire alarm control units and/or control unit accessories intended to function as a single system shall be monitored for integrity in accordance with the Common Performance and Monitoring for Integrity – Protected Premises Units/Systems, Section 51.

57.1 effective December 31, 2008

57.2 The faults required by 57.1 shall not affect the intended synchronization of visual or audible notification appliances.

57.2 effective December 31, 2008

57.3 Each interconnected control unit shall have the capability of being monitored separately for alarm, trouble, and supervisory conditions, as applicable.

57.3 effective December 31, 2008

57.4 Unless interconnected control units located at a protected premises are intended to be installed such that the display annunciation at each unit can be simultaneously observed, alarm, supervisory, and trouble conditions, as well as reset, alarm silence, or trouble silence actuation originating at any unit shall be annunciated at each control unit and non-supplementary operator interface.

57.4 effective December 31, 2008

57.5 The time periods for processing and activation of signals between interconnected units shall comply with 33.1.2, 36.1.2, and 38.1.2, as applicable.

57.5 effective December 31, 2008

57.6 The programming of initiating, notification, and signaling points of the interconnected/networked system shall comply with Software, Section 54.

57.6 effective December 31, 2008

57.7 Relays or modules providing signaling between interconnected fire alarm control units shall be arranged to produce a trouble signal at the interconnected unit(s) when all power to the relay or module is removed.

57.7 effective December 31, 2008

57.8 The operation of relays or other modules providing alarm, supervisory, or trouble (or the like) output signaling shall operate as described for one of the following categories:

a) Common – Operates for all of the signals relative to its type (such as alarm, trouble, supervisory).

b) Zone – Operates for specific zone/circuit input signals (non-programmable).

c) Programmable – Operates for any signals for which it is programmed.

The function of the relay or output module shall be clearly defined in the installation wiring diagram/instructions for the product.

57.8 effective December 31, 2008

OTHER TESTS

58 Electrical Ratings Test

58.1 General

58.1.1 A low-voltage circuit of a product shall comply with the limits specified in 3.13(b).

58.1.1 effective December 31, 2008

58.2 Power input circuits

58.2.1 With the product energized from rated voltage and connected to maximum rated load, the input current of the product shall not exceed the marked rating of the product when the product is operated under all conditions of intended use.

58.2.1 effective December 31, 2008

58.2.2 Where the operating voltage of a product is specified at two or more discrete values, the requirement in 58.2.1 shall be applied at each voltage rating.

58.2.2 effective December 31, 2008

58.2.3 Where the input to the product is specified as a voltage range, the input current rating shall be a single value that is equal to or greater than the measured input current obtained at any voltage within the range.

58.2.3 effective December 31, 2008

58.3 Other external circuits

58.3.1 All external circuits shall be electrically rated to permit proper installation of the product using wiring methods permitted by the National Electrical Code, ANSI/NFPA 70. The actual measured values of any circuit shall not exceed the rating for that circuit.

58.3.1 effective December 31, 2008

58.3.2 The electrical rating of a circuit shall indicate the maximum circuit voltage under any operating condition including an open circuit and the maximum circuit current (or wattage for an audio product) under any condition of normal operation.

58.3.2 effective December 31, 2008

58.3.3 Where the circuit is not power limited as defined in the Power-Limited Circuits Test, Section 60, and a circuit fault condition will cause a circuit current in excess of the normal current rating, either:

a) The maximum fault current shall be indicated or

b) The minimum size wire capable of handling the fault current shall be indicated.

There shall be coordination between the maximum fault current and the overcurrent or current limiting protection required in 14.4.

58.3.3 effective December 31, 2008

59 Variable Voltage Operation Test

59.1 The product, when connected to maximum rated load as described in 30.2.2 and subjected to the input voltage conditions described in 59.2 – 59.4, shall operate as intended and without risk of fire or electric shock during all conditions of intended use. At each input voltage, all conditions of intended use are to be maintained until constant temperatures of its parts are reached, or a minimum of two hours.

59.1 effective December 31, 2008

59.2 The product is to be subjected to the following variable voltage conditions:

a) 110 percent of the rated primary input voltage specified in Table 30.1. The secondary power source is to be connected to rated voltage.

b) 110 percent of the marked rated nominal standby battery voltage or rated secondary power input voltage specified in Table 30.1. The primary input voltage is to be disconnected.

c) 85 percent of rated primary input voltage specified in Table 30.1 or at some lower level of transfer voltage as specified in 50.2.1 and 50.2.4. The standby battery or, when provided, a secondary power source shall be disconnected.

d) 85 percent of the marked rated nominal standby battery voltage or rated secondary power input voltage specified in Table 30.1. The primary input voltage is to be disconnected.

59.2 effective December 31, 2008

59.3 In conducting the reduced voltage test, the voltage is to be reduced by a means that will maintain a stable potential of the required value under the most severe conditions of normal loading.

59.3 effective December 31, 2008

59.4 The reduced voltage tests are to be made with the maximum line impedance as indicated in the installation wiring diagram connected to all external circuit(s).

59.4 effective December 31, 2008

59.5 The increased voltage tests are to be made with zero line impedance in each external circuit.

59.5 effective December 31, 2008

59.6 In those cases where different components or units of a combination system obtain power from separate sources, each source is to be independently varied while the system is tested for its normal operation.

59.6 effective December 31, 2008

59.7 A product intended to be used with a standby battery shall have sufficient capacity to maintain a charged battery under all conditions of intended operation, including sufficient capacity to operate the product with the battery disconnected or fully discharged. In any operating mode, the battery charger shall be capable of maintaining the battery in the charged condition when the product input is at a maximum of 85 percent of rated voltage or at some lower level of transfer voltage as determined according to 50.2.1 – 50.2.5.

59.7 effective December 31, 2008

59.8 A charged battery is defined as a battery having the capacity to maintain the product in the normal supervisory and alarm conditions for the time period required in the Charging Current Test, Section 63, or the Standby Operating Power Test for Releasing Device Service, Section 64.

59.8 effective December 31, 2008

59.9 A releasing-device control unit or local control unit acceptable for release of an extinguishing agent is to be tested for operation at the lower voltage specified in 59.2(c). With the maximum number of squibs or other releasing actuating devices connected, each releasing actuating device shall operate properly and completely upon actuation.

59.9 effective December 31, 2008

60 Power-Limited Circuits Test

60.1 General

60.1.1 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.

60.1.2 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 60.1 for AC circuits or Table 60.2 for DC circuits.

Table 60.1
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. 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, 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.

NOTE – Reproduced in part from the National Electrical Code, ANSI/NFPA 70, copyright National Fire Protection Association, Quincy, MA 02269.

Table 60.2
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. 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, 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.

NOTE – Reproduced in part from the National Electrical Code, ANSI/NFPA 70, copyright National Fire Protection Association, Quincy, MA 02269.

60.1.3 Relative to 60.1.2, 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).

60.1.4 Relative to 60.1.2, 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.

60.1.5 The overcurrent protection device specified in 60.1.2 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.

60.1.6 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.

60.1.7 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.

60.1.8 The loads referenced in 60.2.1 – 60.4.1 shall be resistive.

60.2 Maximum voltage

60.2.1 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 60.1 or 60.2.

60.3 Maximum current

60.3.1 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 Tables 60.1 and 60.2. 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 60.1 or 60.2.

60.3.2 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 60.3.1, and continues until the current is continuously below the I_{max} value indicated in Table 60.1 or 60.2. The time period is to include any momentary period where the output current temporarily drops below the required I_{max} value limit.

60.3.3 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 Tables 60.1 or 60.2.

60.3.4 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 60.1 or 60.2. The results are in compliance when the I_{max} value stated in Table 60.1 or 60.2 cannot be maintained for more than 5 seconds.

60.4 VA_{max} (not inherently limited circuits only)

60.4.1 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 60.1 or 60.2, as appropriate.

61 Compatibility Tests

61.1 General

61.1.1 The interconnection of the product with other devices shall be evaluated for the purpose of operating as a coordinated system relative to the intended signaling and without risk of fire, electric shock, or injury to persons.

61.1.2 The requirements in 61.1.1 apply to products connected to or providing circuits described in 61.2.1.1 – 61.6.13.3, and by which the operating parts of the product are actuated for signaling and/or action.

61.2 Notification appliance circuits (NAC)

61.2.1 Rating

61.2.1.1 All notification appliance circuits of a product shall be identified by one of the rating designations shown in Table 61.1.

Exception: Output circuits intended to be connected to speakers shall comply with the output parameters specified in the Standard for Amplifiers for Fire Protective Signaling Systems, UL 1711.

61.2.1.1 effective December 31, 2008

Table 61.1
Voltage types and ratings

Table 61.1 effective December 31, 2008

Rating designation	Voltage type	Maximum RMS voltage range limits
Regulated 12 DC	DC	8 – 17.5
Regulated 24 DC	DC	16 – 33
Regulated 12 FWR	FWR	8 – 17.5
Regulated 24 FWR	FWR	16 – 33
Regulated 120 AC	AC	96 – 132
Regulated 240 AC	AC	192 – 264
Special application	Any	Rated

61.2.2 Voltage measurement test

61.2.2.1 While the product is energized at the voltage extremes described in the Variable Voltage Operation Test, Section 59, the voltage of the circuit shall be maintained within the voltage range limits shown in Table 61.1, under the load conditions indicated in Table 61.2 for circuits rated “regulated”, and Table 61.3 for circuits rated “special application”.

Exception: Products with notification appliance circuits intended for connection to a synchronized repetitive pulsing load are not required to be subjected to Condition 4 in Table 61.2 and Condition 3B in Table 61.3.

61.2.2.1 effective December 31, 2008

Table 61.2
Regulated NAC circuits

Table 61.2 effective December 31, 2008

Condition	Magnitude	Duration	Frequency	Required circuit voltage
1 (non-pulsing load)	Minimum circuit rating	Continuous	Continuous	Rated RMS value
2 (non-pulsing load)	Maximum circuit rating	Continuous	Continuous	Rated RMS value
3 (synchronized repetitive pulsing load)	Impedance load equal to 5 times the maximum circuit rating	16.7 milliseconds	2 hertz	Rated RMS value during individual application of surge impedance

Table 61.2 Continued on Next Page

Table 61.2 Continued

Condition	Magnitude	Duration	Frequency	Required circuit voltage
4 (non-synchronized repetitive pulsing load)	Impedance load equal to the maximum circuit rating plus the greater of the following currents: a) A value equal to 1.5 times the maximum single notification appliance operating RMS current rating specified to be connected to the circuit. b) A value equal to 4 times the maximum single notification appliance operating RMS current rating specified for connection to the circuit where the maximum number of appliances exceed 30.	Continuous	Continuous	Rated RMS value

Table 61.3
Special application NAC circuits

Table 61.3 effective December 31, 2008

Condition	Magnitude	Duration	Frequency	Required circuit voltage
1 (non-pulsing load)	Minimum circuit rating	Continuous	Continuous	Rated RMS value
2 (non-pulsing load)	Maximum circuit rating	Continuous	Continuous	Rated RMS value
3A (synchronized repetitive pulsing load)	Impedance load equal to the maximum peak of the repetitive surge current of the notification appliance multiplied by the specified maximum number of corresponding notification appliance to be used on the circuit.	See note (1)	2 hertz	Rated RMS value during individual application of surge impedance
3B (non-synchronized repetitive pulsing load)	Impedance load equal to the maximum circuit rating plus the greater of the following currents: a) A value equal to 1.5 times the maximum single notification appliance operating RMS current rating specified to be connected to the circuit. b) A value equal to 4 times the maximum single notification appliance operating RMS current rating specified for connection to the circuit where the maximum number of appliances exceed 30.	Continuous	Continuous	Rated RMS value

Table 61.3 Continued on Next Page

Table 61.3 Continued

Condition	Magnitude	Duration	Frequency	Required circuit voltage
4	Connected to the maximum specified number of the notification appliance to be used on the circuit.	See note (2)	See note (2)	See note (2)

NOTES

1) Surge current time frame window specified by the manufacturer of the special application notification appliance.

2) The combination of product and notification appliance shall comply with the Signal Strength and Format Test in the Standard for Signaling Devices for the Hearing-Impaired, UL 1971, or the Standard for Visual Signaling Appliances – Private-Mode Emergency and General Utility Signaling, UL 1638, and/or the Audibility Test in the Standard for Aud ble Signal Appliances, UL 464, as applicable.

61.2.2.2 The circuit voltage shall additionally be maintained within the voltage range limits shown in Table 61.1 for Conditions 2 and 4 in Table 61.2 and Conditions 2, 3B, and 4 in Table 61.3 when maximum specified line loss calculations are utilized.

61.2.2.2 effective December 31, 2008

61.2.2.3 Products not intended for use with synchronized appliances and employing the additional information specified in 90.4(d) are not required to be subjected to:

a) Condition 3 in Table 61.2;

b) Condition 3A in Table 61.3;

c) Condition B in Table 61.4; or

d) Condition A2 or B2 in Table 61.5.

61.2.2.3 effective December 31, 2008

Table 61.4
Regulated NAC circuits – surge current immunity loading

Table 61.4 effective December 31, 2008

Condition	Magnitude	Duration	Frequency
A (initial surge current load)	Impedance load equal to 10 times the current rating for the NAC circuit.	16.7 milliseconds	Once per minute
B (repetitive surge current load)	Impedance load equal to 5 times the current rating for the NAC circuit.	16.7 milliseconds	2 hertz

Table 61.5
Special application NAC circuits – surge current immunity loading

Table 61.5 effective December 31, 2008

Condition	Magnitude	Duration	Frequency	Cycles
A1 (initial surge current load)	Impedance load equal to the maximum peak of the initial surge current multiplied by the specified maximum number of corresponding notification appliance to be used on the circuit.	See note (a)	Once per minute	50
A2 (repetitive surge current load)	Impedance load equal to the maximum peak of the repetitive surge current multiplied by the specified maximum number of corresponding notification appliance to be used on circuit.	See note (a)	2 hertz	50
B1 (initial surge current load)	Connected to the maximum specified number of the notification appliance to be used on the circuit.	Circuit cycled into the alarm condition for 5 seconds	Once per minute	50
B2 (repetitive surge current load)	Connected to the maximum specified number of the notification appliance to be used on the circuit.	Circuit activated in alarm condition for 15 minutes	n/a	n/a
[a] Surge current time frame window specified by the manufacturer of the special application notification appliance.				

61.2.2.4 For circuits rated as ″special application″, the loads specified in Conditions 1 and 2, and either 3(A and B) or 4, in Table 61.3 shall be applied. The test shall be repeated for each model notification appliance specified in the installation instructions.

61.2.2.4 effective December 31, 2008

61.2.2.5 Refer to 90.4(d) for the required rating information to be included in the installation wiring diagram/instructions.

61.2.2.5 effective December 31, 2008

61.2.3 Surge current immunity

61.2.3.1 While the product is energized from a source of supply in accordance with Table 30.1, the product shall operate as intended and:

a) Not falsely annunciate alarms or troubles;

b) Not reset during an alarm condition;

c) Not cause product failure; and

d) Not cause overcurrent or current-limiting devices to operate,

when each notification appliance circuit is subjected to the tests described in 61.2.3.2 – 61.2.3.4.

61.2.3.1 effective December 31, 2008

61.2.3.2 Each circuit shall be subjected to electrical noise created by the momentary opening of the circuit with a series connected relay contact. The relay contact shall be unflashed silver with a minimum air gap between contacts of 2 millimeters. The relay shall be operated at a rate of 10 cycles per second, with a 50 percent on-/off-duty cycle, for a total of 15 minutes. During this test, the product shall be placed in the alarm condition and connected to maximum rated load(s) with the load of the circuit under test adjusted to a 0.6 power factor.

61.2.3.2 effective December 31, 2008

61.2.3.3 Each circuit designated ″regulated″ as indicated in Table 61.1 shall be subjected to fifty cycles of each of the resistive loads specified in Table 61.4.

61.2.3.3 effective December 31, 2008

61.2.3.4 A notification appliance circuit that is designated as ″special application″ as indicated in Table 61.1 shall be connected to the loads indicated in either Condition A(1 and 2) or B(1 and 2) in Table 61.5. The test shall be repeated for each model notification appliance specified in the installation instructions.

61.2.3.4 effective December 31, 2008

61.3 Power output circuits

61.3.1 A circuit of a product that supplies only operating power to other system products shall be identified in the installation instructions as being a regulated or a special application output. A regulated output shall comply with 61.3.2 – 61.3.4 and shall have a single voltage rating. A special application output shall comply with 61.3.5 and 61.3.6.

61.3.2 The output voltage of a regulated circuit shall not exceed 110 percent of rated voltage when no load, or a minimum load specified by the manufacturer, is connected to all output circuits of the product and while the primary operating input voltage to the product is adjusted to 110 percent of rated value. Any secondary operating power to the product is to be disconnected during this test.

61.3.3 The output voltage of a regulated circuit shall not be less than 85 percent of rated voltage when the input operating voltage to the product is adjusted to 85 percent of rated value or to 1 V above the low-voltage level transfer voltage as determined in accordance with 50.2.4, whichever is less. During this test, any secondary operating power to the product shall be disconnected, all circuits of the product shall be connected to maximum rated load (as determined at rated input voltage), and with maximum line resistance connected to the circuit under test.

61.3.4 For products using a standby battery, the same regulation (85 – 110 percent of rating) shall be maintained at the regulated output circuit with the AC power disconnected and when the battery voltage is varied between 85 – 110 percent of the nominal marked battery rating, under the circuit load conditions described in 61.3.2 and 61.3.3, respectively.

61.3.5 A power output circuit that has a voltage deviation greater than permitted in 61.3.2 – 61.3.4 shall be identified in the installation instructions as ″special application″. In addition, the installation instructions shall describe by manufacturer's name and model designation, the specific appliance(s) intended to be powered by the circuit.

61.3.6 The output voltage of a special application output shall not deviate more than the operating limits of the specified appliance while the input voltage to the product is varied between 85 and 110 percent under any load condition (full or minimum circuit and product load, and zero or maximum series line resistance). The operating limits of an appliance are the voltage range over which the appliance has been tested during the tests in Sections 31 – 57, and the Variable Voltage Operation Test, Section 59.

61.4 Releasing device circuit

61.4.1 A releasing device circuit that is intended to actuate an extinguishing system shall be identified as a special application output and meet the requirements of 61.3.5 and 61.3.6.

61.4.1 effective December 31, 2008

61.4.2 The releasing devices specified in the installation wiring diagram/instructions shall be connected to the releasing device circuit during the following tests:

a) The Variable Voltage Operation Test, Section 59;

b) The Standby Operating Power Test for Releasing Device Service, Section 64;

c) The Overload Test, Section 66;

d) The Endurance Test, Section 67; and

e) The Transient Tests, Section 71.

61.4.2 effective December 31, 2008

61.5 Signaling line circuit (SLC)

61.5.1 General

61.5.1.1 The overall combination of control unit and device(s) connected to the signaling line circuit (SLC) of a control unit shall comply with the requirements for the device (for examples, smoke detectors complying with the Standard for Smoke Detectors for Fire Protective Signaling Systems, UL 268, and the Standard for Smoke Detectors for Duct Application, UL 268A; heat detectors complying with the Standard for Heat Detectors for Fire Protective Signaling Systems, UL 521; control and monitor modules complying with the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864; notification appliances complying with the Standard for Audible Signal Appliances, UL 464, the Standard for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling, UL 1638, or the Standard for Signaling Devices for the Hearing Impaired, UL 1971; and manual pull stations complying with the Standard for Manual Signaling Boxes for Fire Alarm Systems, UL 38), which transmit a signal to the control unit representative of the sensor portion of the device and/or are addressable.

61.5.1.1 effective December 31, 2008

61.5.1.2 In order to determine compliance with 61.5.1.1, the control unit shall be configured and energized as specified in the installation wiring diagram/instruction and a sample of the device is to be connected to the SLC. In addition, the maximum number of devices or a substitute load of equivalent circuit loading, and the maximum line resistance, capacitance and inductance representative of the signaling line circuit field wiring shall be connected between the device and the control unit. The combination control unit and device shall then be subjected to the applicable requirements of 61.5.2.1 – 61.5.5.2.

61.5.1.2 effective December 31, 2008

61.5.2 Alarm and/or trouble threshold limits

61.5.2.1 The alarm and/or trouble limits determined by the control unit for a device shall comply with the requirements for the device (for examples, see 61.5.1.1). The limits shall be adjusted to include any tolerances of the control unit in the processing and interpretation of signals from the device.

61.5.2.1 effective December 31, 2008

61.5.2.2 Field programming of alarm and/or trouble limits outside of the values determined by 61.5.2.1 are prohibited. Where the limits for a specific device vary for each application, the user shall be either:

a) Required to select the application prior to choosing alarm or trouble limits, where any field selectable limits are applicable for the application or

b) Limited to selecting alarm and/or trouble values to the most restrictive of the combined ranges for the various applications.

61.5.2.2 effective December 31, 2008

61.5.2.3 In order to determine compliance with 61.5.2.1, the alarm and trouble values processed and interpreted by the control unit shall be compared to corresponding known signals transmitted from the device while the product/device combination is subjected to the following tests:

a) The Variable Voltage Operation Test, Section 59;

b) The Variable Ambient Temperature and Humidity Test, Section 65;

c) The Overload Test, Section 66;

d) The Endurance Test, Section 67; and

e) The Jarring Test, Section 68; and

f) The Transient Tests, Section 71.

61.5.2.3 effective December 31, 2008

61.5.3 Variable voltage device sensitivity testing

61.5.3.1 Each detector/sensor intended to be used on the SLC shall be within its rated sensitivity limits when subjected to:

a) The sensitivity test in the Standard for Smoke Detectors for Fire Protective Signaling Systems, UL 268, or

b) The oven test, the operating temperature test, or the rate-of-rise operation test, (whichever is applicable) in the Standard for Heat Detectors for Fire Protective Signaling Systems, UL 521.

61.5.3.1 effective December 31, 2008

61.5.3.2 Three samples of each detector/sensor, calibrated to each end of its production window and set at the maximum and minimum sensitivity settings, shall be subjected to the test(s) described in 61.5.3.1 while the control unit is energized from the following conditions:

a) Rated input supply source and

b) The variable voltage conditions described in the Variable Voltage Operation Test, Section 59.

61.5.3.2 effective December 31, 2008

61.5.3.3 The smoke sensitivity measurements at the increased voltage condition shall vary not more than +50 percent from the readings measured at the rated voltage condition and shall not, in any case, exceed the limits specified in the sensitivity test in the Standard for Smoke Detectors for Fire Protective Signaling Systems, UL 268.

61.5.3.3 effective December 31, 2008

61.5.3.4 The smoke sensitivity measurements at the reduced voltage condition shall vary not more than 50 percent from the readings measured at the rated voltage condition and shall not, in any case, exceed the limits specified in the sensitivity test in the Standard for Smoke Detectors for Fire Protective Signaling Systems, UL 268.

61.5.3.4 effective December 31, 2008

61.5.3.5 The sensitivity tests on a heat detector shall comply with the test(s) described in 61.5.3.1, when the control unit is subjected to the variable voltage conditions described in 61.5.3.2.

61.5.3.5 effective December 31, 2008

61.5.3.6 Devices other than detectors/sensors shall perform their intended signaling function while the combination control unit/device is subjected to the Variable Voltage Operation Test, Section 59.

61.5.3.6 effective December 31, 2008

61.5.4 Drift compensation

61.5.4.1 Where a product uses a drift compensation algorithm to automatically shift the alarm threshold to maintain the same overall sensitivity of the smoke detector, the combination shall comply with the requirements in 55.5.1 – 55.5.3.

61.5.4.1 effective December 31, 2008

61.5.4.2 Two samples of each smoke detector and one sample of the product shall be subjected to the conditions described in 61.5.4.3. One sample of the smoke detector shall be set at the maximum production clean air setting and the highest production gain, while the other shall be set at the lowest production clean air setting and the lowest production gain.

61.5.4.2 effective December 31, 2008

61.5.4.3 While the product is energized from a source of supply in accordance with Table 30.1, each smoke detector shall be subjected to the sensitivity test described in the sensitivity test in the Standard for Smoke Detectors for Fire Protective Signaling Systems, UL 268. The product sensitivity setting for the low gain smoke detector shall be the least (minimum) sensitivity value and the sensitivity setting for the high gain detector shall be the most (maximum) sensitivity setting. The measured sensitivities shall be within the rated limits for the detector.

61.5.4.3 effective December 31, 2008

61.5.4.4 A contamination is then to be introduced into each detector and the product/detector combination allowed to compensate. The process is to be repeated, increasing the contamination within the detector, until the detector is at the point where the maximum amount of compensation has been provided. The sensitivity test described in 61.5.4.3 is to be repeated. This sensitivity shall be within 0.5 percent/Ft. obscuration of the initial sensitivity measurement for the same detector.

61.5.4.4 effective December 31, 2008

61.5.5 Calibrated smoke detector sensitivity confirmation testing

61.5.5.1 When the product is intended to correctly interpret the sensitivity of the smoke detectors as required in 55.6.1 – 55.6.4, samples of the each smoke detector shall be subjected to the sensitivity test described in the Standard for Smoke Detectors for Fire Protective Signaling Systems, UL 268. The measurements shall be within ±0.5 percent/Ft obscuration of the values displayed on the product or at the point of annunciation of a trouble condition when the detector is not within the required sensitivity limits, ±0.5 percent/Ft obscuration.

61.5.5.1 effective December 31, 2008

61.5.5.2 While the product is energized from a source of supply in accordance with Table 30.1, two samples of each smoke detector shall be subjected to the sensitivity test. One sample of the smoke detector shall be set at the maximum production clean air setting and the highest production gain, while the other shall be set at the lowest production clean air setting and the lowest production gain.

61.5.5.2 effective December 31, 2008

61.6 Two-wire conventional smoke detectors

61.6.1 General

61.6.1.1 Compatibility between a two-wire smoke detector that receives its power from the initiating device circuit of a fire alarm system control unit or product is dependent upon the interaction between the circuit parameters, such as voltage, current, frequency, and impedance, of the detector and the initiating device circuit.

61.6.1.2 A detector that does not receive its power from the initiating device circuit of a control unit (conventionally a detector having four or more wires for field connection) may be employed with any electrically compatible fire alarm system control unit without the need for two-wire smoke detector compatibility consideration as its connection does not impose any load on the initiating circuit. Under an alarm condition, the four-wire detector acts as a switch (similar to a manual station or heat detector) to place the system in alarm.

61.6.1.3 As a two-wire detector obtains its power from the initiating device circuit of a system control unit, its operation is dependent on the characteristics of the circuit to which it is connected as the detector imposes a resistive and capacitive load on the circuit. Similarly, the load imposed upon the initiating circuit by a connected detector must not prevent alarm response by a control unit to a detector in alarm, nor prevent a trouble response to an open circuit after the last detector.

61.6.1.4 The connection of a two-wire smoke detector is restricted to the specific control units or initiating-device circuits with which a compatibility evaluation has been made.

61.6.1.5 A supplementary signaling device [such as an audible appliance, relay, or annunciation lamp (LED)] that is integral with a two-wire smoke detector and that is also powered from an initiating device circuit of a fire alarm system control unit is not to be used unless its operation, including level of audibility and light output, is not inhibited under the maximum normal standby and alarm loading conditions specified in the detector and control unit installation wiring diagrams.

61.6.1.6 In accordance with 61.6.1.1 – 61.6.1.5, to determine whether any combination of control unit and smoke detector or detectors is compatible, whether the detectors are the same model or a mixture of one or more models or types, the tests indicated in 61.6.2.1 – 61.6.13.3 are to be conducted.

61.6.1.7 Products employing initiating circuits intended for connection to two-wire smoke detectors shall be marked with a compatibility identifier consistent with 90.15(f).

61.6.1.8 To maintain compatibility integrity after a compatible combination has been installed and that can be affected by replacement detectors or a modification of either the detectors or the control unit, the product that is changed shall be assigned a different model number, or change in the compatibility identification marking.

61.6.2 Operating voltage determination

61.6.2.1 The voltage range determined during conditions described in 61.6.2.2 (a) – (e) shall not be below the minimum, nor above the maximum manufacturer's ratings specified for the control unit initiating circuit. The ripple voltage shall also be less than the maximum manufacturer's specified rating.

61.6.2.2 For control unit/smoke detector compatibility considerations, the operating voltage of an initiating device circuit is determined while the product is operating at each of the conditions specified in (a) – (e), and with any fault for which the circuit is intended to remain operational as specified for the particular class and/or style in 51.2.1:

a) Rated primary and secondary input voltage, maximum initiating circuit series line resistance, and rated load conditions.

b) Overvoltage condition of primary input [see 59.2(a)] with no load on the product, the initiating circuit disconnected from the end-of-line device, zero initiating circuit line resistance, and the standby power source disconnected.

c) Overvoltage condition of the standby input voltage [see 59.2(b)] with no load on the product, the initiating circuit disconnected from the end-of-line device, zero initiating line resistance, and the primary power source disconnected.

d) Undervoltage condition [see 59.2(c)] level of primary input; standby supply disconnected with maximum rated load and maximum initiating circuit series line resistance connected to the product.

e) Primary supply disconnected, standby voltage adjusted to 85 percent of marked rated nominal voltage [see 59.2(d)], maximum load and initiating circuit series line resistance connected to the product.

61.6.2.3 The operating voltage of a two-wire smoke detector is considered compatible with an initiating device circuit if the detector's operating voltage range coincides with or overlaps the initiating circuit rated voltage range at both the high and low end.

61.6.3 Alarm threshold impedance

61.6.3.1 The initiating circuit of a product shall be rated to indicate the maximum impedance that will reliably trip the circuit into the alarm condition.

61.6.3.2 Compliance with 61.6.3.1 is determined by connecting a variable resistor in parallel with the end-of-line device and slowly reducing the resistance until the product latches into the alarm condition.

61.6.3.3 Where a product is intended to signal a second alarm on the same zone (counting zone), the variable resistor described in 61.6.3.2 is to be slowly reduced from the first alarm condition until the product latches into the second alarm condition.

61.6.3.4 The test is repeated for the conditions described in 61.6.2.2 (a) – (e). The lowest resistance setting recorded that will trip the alarm condition shall be equal to or greater than the rated value.

61.6.4 Maximum current limitations

61.6.4.1 Some two-wire smoke detectors that do not include internal current limitation are susceptible to damage during the alarm condition if the initiating circuit available current exceeds the detector maximum current ratings. A two-wire detector is considered compatible with a product initiating circuit when the maximum available initiating circuit current does not exceed the maximum alarm current rating of the noncurrent-limited detector, when the circuit is loaded with a single detector, or equivalent impedance, in the alarm condition.

61.6.4.2 Compliance with 61.6.4.1 is determined by connecting a variable resistor and ammeter across the initiating circuit and reducing the resistance not less than the minimum equivalent impedance of the detector in the alarm condition until maximum current is recorded. This test is repeated for the conditions described in 61.6.2.2 (a) – (e). The maximum recorded current shall not exceed the manufacturer's ratings.

61.6.5 Multiple detector alarm capacity

61.6.5.1 A product initiating circuit intended to respond to or support more than one smoke detector in the alarm condition shall maintain a rated voltage as determined by 61.6.2.2 (a) – (e) while connected to the minimum impedance that would be imposed by one or more detectors in the alarm condition. Unless the product is intended to be compatible with only one smoke detector, the minimum alarm impedance shall be expressed in range of voltage versus current or impedance values.

61.6.6 Detectors with required accessories and/or optional components

61.6.6.1 Some smoke detectors incorporate required accessories such as LEDs and/or optional components such as relays and audible devices. These accessories and optional components are intended to operate during the alarm condition, and therefore, the initiating circuit shall maintain rated voltage during the alarm condition to provide intended operation of these accessories and optional components.

61.6.6.2 When a product initiating circuit is intended to be used with a detector as described in 61.6.6.1, the product shall be rated to indicate the minimum impedance during the alarm condition (minimum alarm impedance) that will permit minimum rated alarm condition voltage during conditions specified in 61.6.2.2 (a) – (e). Unless the product is intended to be compatible with only one smoke detector, the minimum alarm impedance shall be expressed in range of voltage versus current or impedance values.

61.6.7 Dynamic load immunity

61.6.7.1 A product having initiating-device circuits intended for use with two-wire smoke detectors with pulsing normal operating current shall not false alarm due to the random pulsing load presented by the maximum number of detectors permitted to be connected to the circuit.

61.6.7.2 The product is to be energized from a source of rated voltage and frequency and the maximum number of two-wire smoke detectors specified in the installation wiring diagram are to be connected to an initiating device circuit. The combination is to be operated in the normal supervisory condition for 30 days. During that time, no false alarms shall occur. The test is repeated for each type and combination of smoke detector specified on the installation wiring diagram.

Exception No. 1: A product that provides an alarm retard on the initiating device circuit of 1 – 3 seconds is not required to be subjected to the test if the two-wire detectors intended to be connected to the circuits have a power pulse duration, in seconds, equal to or less than the reciprocal of the maximum number of detectors.

Exception No. 2: The impedance representative of the combined peak pulse currents of the maximum number of smoke detectors specified in the installation wiring diagram pulsing simultaneously is greater than the minimum normal standby impedance rating (see 61.6.9.1 – 61.6.9.3) for the initiating circuit.

61.6.8 Electrical supervision

61.6.8.1 A product, while connected to the maximum number of two-wire detectors indicated on the installation wiring diagram, shall provide supervision of an open circuit beyond the last detector in the initiating device circuit. The trouble signal shall be the same with or without detectors connected.

61.6.8.2 The product shall produce the same type of audible trouble signal when operated in conditions described in 61.6.2.2 (a), (b), and (d).

61.6.9 Maximum capacitance loading

61.6.9.1 The initiating circuit of a product shall be rated to indicate the maximum capacitance loading that can be placed on the circuit without affecting the normal operating characteristics.

61.6.9.2 Compliance with 61.6.9.1 is determined by connecting the maximum specified capacitance in parallel with the end-of-line device simultaneously with the operation of the product's reset switch and confirming that the circuit resets to the normal supervisory condition.

61.6.9.3 The test is repeated for the conditions described in 61.6.2.2 (a) – (e).

61.6.10 Alarm reset voltage and time

61.6.10.1 The initiating circuit of a product shall be rated to indicate the maximum alarm reset voltage and the minimum alarm reset time.

61.6.10.2 Compliance with 61.6.10.1 is determined by activating the reset switch and recording:

a) The highest voltage which remains on the initiating circuit and

b) The time interval the circuit was de-energized below the maximum specified reset voltage.

61.6.10.3 The test is repeated for the conditions described in 61.6.2.2 (a) – (e). The maximum voltage recorded shall be equal to or less than the rated value. The minimum time interval measured shall be equal to or greater than the rated value.

61.6.11 Alarm verification (optional)

61.6.11.1 Products providing alarm verification shall meet the timing requirements specified in 55.2.1 – 55.2.8.

61.6.12 Minimum normal standby impedance (optional)

61.6.12.1 The initiating circuit of the product shall be rated to indicate the minimum impedance that will reliably not trip the circuit into the alarm condition.

61.6.12.2 Compliance with 61.6.11.1 is determined by conducting the test described in 61.6.3.1 – 61.6.3.4. The test is repeated for the conditions described in 61.6.2.2 (a) – (e).

61.6.12.3 The highest impedance recorded that will trip the alarm condition shall be less than the rated value.

61.6.13 Minimum impedance where second alarm will not occur (optional)

61.6.13.1 The initiating circuit of the product shall be rated to indicate the minimum impedance that will reliably not result in the occurrence of the second alarm condition for a counting zone.

61.6.13.2 Compliance with 61.6.12.1 is determined by conducting the test described in 61.6.3.1 – 61.6.3.4. The test is repeated for the conditions described in 61.6.2.2 (a) – (e).

61.6.13.3 The highest impedance recorded that will trip the second alarm condition shall be less than the rated value.

62 Component Temperature Test

62.1 A product, when operated under any normal condition of intended use and at maximum rated load, shall not reach a temperature at any point high enough to:

a) Result in a risk of fire or electric shock;

b) Adversely affect any materials in the product; or

c) Exceed the temperature rises at specific points as specified in Tables 62.1 and 62.2.

Exception: A component with a temperature exceeding that indicated in Table 62.1 is not prohibited from being used when reliability data at the higher temperature is provided by the manufacturer to justify its use.

Table 62.1
Maximum temperature rises – electronic components

Component or device	Normal standby (continuous), °F	(°C)	Alarm condition (constant temperatures), °F	(°C)
A. COMPONENTS				
1. Capacitors[a]	45	25	72	40
2. Resistors[b]				
Carbon	45	25	45	25
Wire-wound	90	50	585	325
B. SOLID-STATE DEVICES	See note (c)			

[a] In lieu of complying with these temperature limits, a component shall meet the derating parameters specified in Table 53.1.

[b] In lieu of complying with these temperature limits, a resistor shall not dissipate more than one-half of its maximum power rating under the test conditions specified.

[c] The temperature of a solid-state device (such as a transistor, SCR, or integrated circuit) shall comply with one of the following:

1) Not exceed:

a) 50 percent of its rated junction temperature, or storage temperature when not rated for junction temperature, during the normal standby condition or

b) 75 percent of its rated junction temperature, or storage temperature when not rated for junction temperature, under the alarm condition or any other condition of operation which produces the maximum temperature dissipation of the component.

For reference purposes, 32°F (0°C) shall be determined 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 condition of operation.

2) Not exceed 100 percent of its rating under any condition of normal use and the component is subjected to one of the following:

a) The component complies with the requirements of MIL-STD 883E;

b) A quality control program established by the manufacturer consisting of inspection and testing of all pertinent parameters of 100 percent of components either on an individual basis, as part of an assembly, or the equivalent.

c) 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 120°F (49°C), followed by an operation test for normal signaling performances.

Table 62.2
Maximum temperature rises – materials and component parts

Table 62.2 revised July 14, 2005

Materials and component parts	°F	(°C)
1. Varnished cloth insulation	108	60
2. Fuses:		
a) Class G, J, L, and CC:		
Tube	180	100
Ferrule or blade	153	85
b) Others	117	65
3. Fiber used as electrical insulation	117	65
4. Wood and similar combustible material	117	65
5. Any point on or within a terminal box on a permanently wired unit (see 89.1.8)	117	65
6. A surface upon which a permanently wired unit is mounted in service, and surfaces that are adjacent to the unit when it is so mounted	117	65
7. Enclosure surfaces:		
a) Surfaces subject to contact during intended use or maintenance:		
Metallic	63	35
Nonmetallic	108	60
b) Other surfaces:		
Metallic	81	45
Nonmetallic	126	70
8. Class 105 (formerly Class A) insulation systems on windings of relays, solenoids, magnets, and similar parts:		
Thermocouple method	117	65
Resistance method	153	85
9. Class 130 (formerly Class B) insulation systems on windings of relays, solenoids, magnets, and similar parts:		
Thermocouple method	153	85
Resistance method	189	105
10. Class 155 insulation systems on windings of relays, solenoids, magnets, and similar parts:		
Thermocouple method	198	110
Resistance method	216	120
11. Class 180 insulation systems on windings of relays, solenoids, magnets, and similar parts:		
Thermocouple method	225	125
Resistance method	243	135
12. Phenolic composition used as electrical insulation or as a part whose malfunction is capable of resulting in a risk of fire, electric shock, injury to persons or risk from electrical-energy/high-current levels[a].	225	125
13. Insulated conductors, appliance wiring material	see note b	
14. Transformers with Class 105 insulation systems:		
Thermocouple method	117	65
Resistance method	135	75
15. Transformers with Class 130 insulation systems:		
Thermocouple method	153	85
Resistance method	171	95
16. Transformers with Class 155 insulation systems:		
Thermocouple method	198	110
Resistance method	216	120
17. Transformers with Class 180 insulation systems:		

Table 62.2 Continued on Next Page

Table 62.2 Continued

Materials and component parts	°F	(°C)
Thermocouple method	225	125
Resistance method	243	135
18. Sealing compound	72°F (22°C) less than melting point	
19. Printed-wiring board	see note c	

[a] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and determined to meet the requirements for use at higher temperatures.

[b] 77°F (25°C) less than the established temperature rating of the wire.

[c] Temperatures on the surface of any printed-wiring board shall not exceed the temperature limits of the board.

62.2 All values for temperature rise apply to equipment intended for use with ambient temperatures normally prevailing in occupiable spaces which usually are not higher than 77°F (25°C). When equipment is intended specifically for use with a prevailing ambient temperature constantly more than 77°F, the test of the equipment is to be made with the higher ambient temperature, and the allowable temperature rises specified in Tables 62.1 and 62.2 are to be reduced by the amount of the difference between that higher ambient temperature and 77°F.

62.3 Temperature measurements on equipment intended for recessed mounting are to be made with the unit installed in the intended manner on or against the black painted surface of an enclosure of 3/4 inch (19.1 mm) wood such that the walls of the enclosure make a close fit with the product and extending approximately 2 inches (50.8 mm) on the top, sides and rear, and the front extended to be flush with the product cover.

62.4 A product shall be connected to a supply circuit of rated voltage. A product having a single frequency rating is to be tested at that frequency. A product rated AC/DC or DC – 60 hertz is to be tested at both direct current and 60-hertz alternating current. A product rated 25 – 60 hertz or 50 – 60 hertz is to be tested on 50-hertz alternating current.

62.5 A product that is rated for use at more than one voltage or for a range of voltages shall be tested at each supply voltage.

62.6 A product that is rated for use at more than one voltage, or a range of voltages, and contains a tapped transformer or other means of being adapted to different supply voltages shall be tested at the most unfavorable combination of supply voltage and voltage adjustment.

Exception: The product is to be tested while connected according to the manufacturer's instructions when the product is marked according to 89.1.21.

62.7 For the purpose of prescreening, thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2), and an infrared temperature probe or the equivalent, are not prohibited from being employed to identify those components and/or materials in which compliance with 62.1 is questionable and, therefore, requiring the measurements indicated in 62.8.

62.8 Temperatures are to be measured by thermocouples except the change-of-resistance method shall be used for coil and winding temperatures where the coil is inaccessible for mounting of thermocouples (for example, a coil immersed in sealing compound) or where the coil wrap includes thermal insulation or more than two layers [1/32 inch (0.8 mm) maximum in total thickness] of cotton, paper, rayon, or the like.

62.9 Whenever temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wire and a potentiometer-type instrument are to be used. The thermocouple wire is to conform with the requirements in the Initial Calibration Tolerances for Thermocouples table in Temperature-Measurement Thermocouples, ANSI/ISA MC96.1.

62.10 The temperature of a copper coil winding is determined by the change-in-resistance method, wherein the resistance of the winding at the temperature to be determined is compared with the resistance at a known temperature by means of the formula:

$$T = \frac{R}{r}(234.5 + t) - 234.5$$

in which:

T is the temperature to be determined in degrees C;

R is the resistance in ohms at the temperature to be determined;

r is the resistance in ohms at the known temperature; and

t is the known temperature in degrees C.

62.11 As it is generally necessary to de-energize the winding before measuring R, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to give the value of R at shutdown.

62.12 The circuit of a current-regulating resistor or reactor provided as part of a product is to be adjusted for the maximum resistance or reactance at rated load.

62.13 Component temperature is to be determined while the product is operated under the following conditions:

a) Normal supervisory condition until constant temperatures occurs. If the product is intended to charge standby batteries, this test shall be conducted while connected to a discharged battery (as defined in 63.2.1 – 63.2.5).

b) Alarm condition under maximum rated load conditions until constant temperatures occur.

62.14 A temperature is determined to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5-minute intervals, indicate no change.

62.15 In a product having provision for multiple zones, all initiating circuits shall be actuated during the alarm condition.

62.15 effective December 31, 2008

62.16 A product which is intended to provide coded impulse signals is to be operated by a testing device, such as a timer switch, at a rate of 120 impulses per minute; except that, if the signal impulses are produced normally by a device which is a part of the product, the test impulses are to be at the maximum rate permitted by the design.

62.17 When a time-limit cutout is provided as part of the product, and is not intended to limit the time of alarm-signal operation, it is to be shunted out of the circuit for the duration of the test.

63 Charging Current Test

63.1 General

63.1.1 This test is to be conducted in conjunction with the Component Temperature Test, Section 62, on products provided with standby batteries.

63.1.2 Except as indicated in 63.1.3, the test method specified in 63.2.1 – 63.4.1 shall be followed.

63.1.3 Where the product:

a) Specifies 5 minutes of alarm load;

b) Uses sealed lead acid batteries;

c) Uses the constant voltage charging method or a combination of the constant current and constant voltage charging method;

d) Specifies a minimum 10 percent battery de-rating factor in the installation wiring diagram; and

e) Meets all of the following parameters:

1) Float voltage between 2.3 – 2.4 V per cell;

2) Minimum initial charging current is at least C/20 amps as measured using a discharged battery; and

3) Maximum rated alarm load is C/2 amps (in which ″C″ equals amp hour battery capacity),

the test method described in 63.2.1 – 63.4.1 shall be waived. For all testing requiring a discharged battery load, including the Component Temperature Test, Section 62, a discharged battery or equivalent load set to draw the maximum charging current shall be placed on the battery-charging circuit-output terminals.

63.2 Discharged battery

63.2.1 The terminal voltage of a battery discharged as specified in 63.2.2 – 63.2.5 shall not be less than 85 percent of the marked nominal battery voltage.

63.2.2 The battery is first to be charged by applying AC input power to the product for 48 hours, during which the product is to be operated continuously with normal standby load connected. AC input is then to be disconnected, and terminal voltage of the battery is to be measured one minute after disconnection.

63.2.3 The battery is then to be discharged by maintaining the normal standby load connected to the output for the applicable period specified in (a), (b), or (c):

a) 4 hours, where secondary (standby) power is intended to be used in conjunction with an automatic-starting engine-driven generator;

b) 24 hours; or

c) A longer than 24-hour period as described in the installation document of the product.

63.2.4 For products which normally have no status change signaling operations during the discharge period, the normal standby load shall be the quiescent current of the product plus any specified normal supervisory power supply loads not automatically disconnected upon transfer to secondary power. For products which will normally have status-change signaling occurring throughout the discharge period (DACR, RF repeaters) and which draw more operating current when signaling then while in the quiescent mode, the normal standby load shall be a steady state load equal to the signaling current of the product plus any specified normal supervisory power supply loads not automatically disconnected upon transfer to secondary power.

63.2.4 effective December 31, 2008

63.2.5 At the conclusion of the discharge period, all products operating alarm notification appliances used for evacuation or to direct aid to the location of an emergency, with the exception of emergency voice/alarm communications systems, shall have the maximum rated alarm load applied for 5 minutes or any longer period as described in the installation document of the product. Emergency voice/alarm communications system shall be subjected to 15 minutes of maximum evacuation alarm load.

63.2.5 effective December 31, 2008

63.3 Charged battery

63.3.1 The terminal voltage of a battery charged as specified in 63.3.2 shall be at least 95 percent of the voltage measured in 63.2.2.

63.3.2 At the conclusion of the test sequence described in 63.2.2 – 63.2.5, AC input power is to be reapplied to the product for 48 hours. During charging, the product is to be operated continuously with normal standby load connected. At the conclusion of the 48-hour recharge time, AC power is to be disconnected and battery terminal voltage measured after one minute.

63.4 Discharged battery – second trial

63.4.1 The terminal voltage of a battery shall not be less than 85 percent of the marked nominal battery voltage after the battery has been discharged as specified in 63.2.3 and 63.2.5 following charging as specified in 63.3.2.

64 Standby Operating Power Test for Releasing Device Service

64.1 While connected to each releasing device specified in the installation document, products controlling devices for release of an extinguishing agent shall be capable of activating the releasing device after 24 hours of operation of the standby source of power with which it is provided. When the primary AC power to the product is momentarily reconnected prior to operation for extinguishant release, the resulting internal electrical transients shall not cause false operation of the release mechanism or circuitry.

64.1 effective December 31, 2008

64.2 Where the system configuration employs cross-zone release or single-zone, multiple-detector actuation, the standby operating source shall be capable of supplying an additional 5-minute alarm signal immediately followed by the capability of releasing the extinguishing agent.

64.2 effective December 31, 2008

64.3 Where a continuous load, such as that created by solenoid release valves, motor mechanisms, and the like, is specified, the standby operating source shall maintain at least 85 percent of the rated operating voltage to the releasing devices after 60 seconds energization of the release circuit. If voltage is less than 85 percent of rated level when 60 seconds have elapsed, the maximum time during which the standby operating source maintains the minimum operating voltage (85 percent of rated voltage) shall be specified in the installation document.

64.3 effective December 31, 2008

65 Variable Ambient Temperature and Humidity Tests

65.1 General

65.1.1 A product shall operate in the intended manner for all conditions of intended use at the test ambient conditions specified in 65.2.1 – 65.4.2.

Exception: Test ambients of 55 ±3°F (13 ±2°C) and 95 ±3°F (35 ±2°C) are permitted to be used and the humidity test is not required to be conducted when all the following conditions are met:

a) The equipment is intended only for use as proprietary or central station supervising stations,

b) The installation instructions indicate:

1) That the equipment is to be installed in an environment constantly maintained between the ambient conditions indicated above and

2) The heating and cooling systems for the controlled environment are supplied by a standby power source capable of sustaining the systems for a minimum standby time of 24 hours.

c) The equipment is marked with the ambient temperature limitations.

65.1.2 The unit is to be energized from a source of rated voltage and frequency, and connected to maximum rated load as described in 30.2.2.

65.1.3 Where a product has a marked rated input voltage expressed in a range of values rather than a single value, each test ambient is to be conducted with the unit energized at the voltage where the unit consumes the maximum power.

65.2 Low temperature test

65.2.1 An indoor dry product (intended for indoor use/dry locations) shall operate as intended following exposure to air at the lower of the following temperatures:

a) 32 ±3°F (0 ±2°C) or

b) The lowest ambient operating temperature specified in the product's marking.

65.2.2 The unit is to be maintained in the normal supervisory condition at the test ambient until thermal equilibrium has been reached (4 hours minimum).

65.2.3 An indoor damp and wet product (intended for indoor use in damp or wet locations) shall operate as intended following exposure to 20 cycles of temperature and humidity cycling. A temperature cycle consists of a change from a temperature of 77 ±9°F (25 ±5°C) at a humidity of 95 ±2 percent relative humidity to the lower temperature indicated in 65.2.1 for a period of 30 minutes, and back to a temperature of 77 ±9°F at a humidity of 95 percent relative humidity. The rate of change shall be 3.6 ±1.8°F (2 ±1°C) per minute.

65.2.4 An outdoor damp and wet product (intended for outdoor use in damp or wet locations) shall operate as intended following exposure to 20 cycles of temperature and humidity cycling. A temperature cycle consists of a change from an ambient of 77 ±9°F (25 ±5°C) at a humidity of 95 ±2 percent relative humidity to the lower of the temperatures indicated in subitem (a) or (b) for a period of 30 minutes, and back to a temperature of 77 ±9°F at a humidity of 95 ±2 percent relative humidity. The rate of change shall be 3.6 ±1.8°F (2 ±1°C) per minute.

a) Minus 40 ±3°F (minus 40 ±2°C) or

b) The lowest ambient operating temperature specified in the product's marking.

65.2.5 For the test method, the product is to be placed in a position of intended use in an air-circulating environmental chamber. The environmental chamber is to be maintained at the appropriate temperature and humidity indicated in 65.2.2 – 65.2.4. At the completion of the exposure, while at the low temperature, the product is to be operated for all conditions of intended use.

65.3 High temperature test

65.3.1 An indoor dry product (intended for indoor use/dry locations) shall operate as intended following exposure to air at the higher of the following temperatures:

a) 120 ±3°F (49 ±2°C) or

b) The highest ambient operating temperature specified in the product's marking.

65.3.2 The unit is to be maintained in the normal supervisory condition at the test ambient until thermal equilibrium has been reached (4 hours minimum).

65.3.3 An indoor damp and wet product (intended for indoor use in damp or wet locations) shall operate as intended following exposure to 20 cycles of temperature and humidity cycling. A temperature cycle consists of a change from a temperature of 77 ±9°F (25 ±5°C) at a humidity of 95 ±2 percent relative humidity to the higher temperature indicated in 65.3.1 for a period of 30 minutes, and back to a temperature of 77 ±9°F at a humidity of 95 ±2 percent relative humidity. The rate of change shall be 3.6 ±1.8°F (2 ±1°C) per minute.

65.3.4 An outdoor damp and wet product (intended for outdoor use in damp or wet locations) shall operate as intended following exposure to 20 cycles of temperature and humidity cycling. A temperature cycle consists of a change from an ambient of 77 ±9°F (25 ±5°C) at a humidity of 95 ±2 percent relative humidity to the higher of the temperatures indicated below for a period of 30 minutes, and back to a temperature of 77 ±9°F at a humidity of 95 ±2 percent relative humidity. The rate of change shall be 3.6 ±1.8°F (2 ±1°C) per minute.

a) 151 ±3°F (66 ±2°C) or

b) The highest ambient operating temperature specified in the product's marking.

65.3.5 For the test method, the product is to be placed in a position of intended use in an air-circulating environmental chamber. The environmental chamber is to be maintained at the appropriate temperature and humidity as indicated in 65.3.1 – 65.3.4. While in the high temperature test ambient, the unit shall be maintained in each condition of intended use, other than normal supervisory, for a minimum of two hours or until constant temperature of its parts is reached.

65.3.5 effective December 31, 2008

65.4 Humidity test

65.4.1 An indoor dry product (intended for indoor use/dry locations) shall operate in the intended manner after having been exposed for 24 hours to moist air having a relative humidity of 93 ±2 percent at a temperature of 90 ±3°F (32 ±2°C). At the completion of the exposure, while at the high humidity, the product is then to be operated for all conditions of intended use.

65.4.2 An indoor or outdoor, damp or wet product (intended for indoor or outdoor use, damp or wet locations) shall operate as intended during and after exposure for 240 hours to air having a relative humidity of 95 ±3 percent and a temperature of 140 ±3°F (60 ±2°C). At the completion of the exposure, while at the high humidity, the product is then to be operated for all conditions of intended use.

66 Overload Test

66.1 Products supplied from commercial AC power systems

66.1.1 A product that obtains power from commercial AC power systems shall not show manifestation of a fire or risk of electrical shock and shall be capable of operating as intended after being subjected to 50 cycles of alarm signal operation at a rate of not more than 15 cycles per minute with the supply circuit at 115 percent of rated voltage, and at rated frequency. During the cycling output circuits that receive energy from the product's power supply shall be connected as described in 66.1.2 – 66.1.5. Each cycle shall consist of starting with the product energized in the normal supervisory condition, actuating for alarm, and returning to the normal supervisory condition. There shall be no electrical or mechanical failure of any of the components of the product.

66.1.2 Rated loads are to be connected to those output circuits of the product that are energized from the product power supply. The loads shall be those devices normally intended for connection or other loads that have been determined to be equivalent. Where an equivalent load is used for a device consisting of an inductive load, the applicable power factor indicated in 66.1.4 is to be used. The rated loads are established initially with the product connected to rated supply voltage and frequency, following which the input supply voltage is raised to 115 percent of rating.

66.1.3 For direct current loads, an inductive load that has been determined to be equivalent is to have the required direct current resistance for the test current and the inductance (calibrated) to obtain the applicable power factor indicated in 66.1.4 when connected to a 60-hertz potential equal to the rated direct current test voltage. When the inductive load has both the required direct current resistance and the required inductance, the AC current measured with the load connected to an alternating current circuit will be equal to the rated DC current multiplied by the applicable power factor indicated in 66.1.4.

66.1.4 For output circuits intended for connection to notification appliances, the power factor is to be 0.60. The power factor of a motor load is to be 0.40 to simulate locked rotor conditions. When a circuit is specified for use in pilot duty applications, the power factor is to be 0.35. A power factor of 1.0 is to be used for all other applications.

66.1.5 Unless the device controlling a motor circuit has a horsepower rating, it is to be tested with the motor stalled.

66.1.6 A product 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.

66.2 Separately energized circuits

66.2.1 A product shall be capable of operating in the intended manner after being subjected to 50 cycles of signal operation at a rate of not more than 15 cycles per minute with the product connected to a source of rated voltage and frequency and 150 percent rated loads applied to output circuits which do not receive energy from the product. There shall be no electrical or mechanical failure of any of the components of the product.

66.2.2 The test loads shall be set at 150 percent of rated current while connected to a separate power source of rated voltage and frequency at the applicable power factor indicated in 66.2.3.

66.2.3 For circuits intended for use with notification appliances, the power factor is to be 0.60 inductive. The power factor of a motor load is to be 0.40, inductive, to simulate locked rotor conditions. When a circuit is specified for use in pilot duty applications, the power factor is to be 0.35, inductive. Circuits rated for use with resistive loads shall use a power factor of 1.0. When no particular load application is specified, the power factor is to be 0.35, inductive.

66.3 Battery charger transfer mechanism

66.3.1 A product using a transfer mechanism in conjunction with a power-supply battery charger or a battery charger shall be capable of operating in the intended manner after the transfer mechanism is subjected to 50 cycles, at a rate of not more than 15 cycles per minute, of the greater of the two following currents:

a) 150 percent of the maximum rated load (normal standby or alarm) current or

b) One that is equivalent to the maximum inrush current entering a discharged battery connected to the charging circuitry (a discharged battery is defined in the Charging Current Test, Section 63).

67 Endurance Test

67.1 General

67.1.1 With the product supply circuit at rated voltage and frequency and with rated devices or equivalent loads connected to the output circuits, a product shall not show a manifestation of a fire or risk of electrical shock and shall be capable of operating in the intended manner after being subjected to repetitive signal operation. In addition, there shall be no electrical or mechanical failure or evidence of approaching failure of the product components. Based upon the frequency of expected use, each circuit of the product shall be tested for the number of cycles and at the rate indicated in Table 67.1.

Exception: When circuits are not capable of the rate indicated in Table 67.1, the test cycle rate shall be the maximum rate permitted by the design of the product.

Table 67.1
Endurance test cycles

Frequency of use	Type operation	Total number of operations	Operations per minute
Daily use	Coded[a]	1,000,000	60
	Noncoded[b]	30,000	15
Occasional use	Coded[a]	250,000	60
	Noncoded[b]	6,000	15

[a] ″Coded″ refers to a repetitive group of on-off signals.
[b] ″Noncoded″ refers to a continuous signal.

67.1.2 The loads or equivalent loads specified in 67.1.1 shall conform to the power factor loading indicated in 66.1.4.

67.2 Integral operating devices

67.2.1 An operating device supplied as a part of a product [such as a switch, relay, or coding mechanism (except a time-limit cutout)], shall perform as intended when operated for the number of cycles and at the rate indicated in Table 67.1. 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 66.2.3. The endurance tests of these devices may be conducted in conjunction with the endurance test on a product.

67.3 Power supplies

67.3.1 A product employing either power-supply circuitry or circuitry for the power-supply battery charger shall operate as intended following 6000 cycles operation as described in 67.3.2.

Exception: For a control unit employing only a battery charger, the product shall operate as intended after 500 cycles as specified in 67.4.1.

67.3.2 With the input of the product connected to a voltage source in accordance with Table 61.1, a resistive load or loads drawing maximum rated output power shall be connected to the power supply output and then alternately applied and removed, or reduced to the manufacturer's specified minimum value at a rate consistent with 67.1.1. Each cycle is to consist of the load application followed by the load removal (or reduction) for an equal time.

67.4 Battery charger

67.4.1 For a product employing battery charger circuitry, the input circuit is to be connected to a source having a rated voltage defined by Table 61.1. A load drawing maximum charging current to a discharged battery, as defined in the Charging Current Test, Section 63, is to be applied to the charger circuitry for 5-second intervals for a total of 500 cycles.

67.5 Printers

67.5.1 A printer, whether separate or integral with a product, shall operate as intended after being subjected to 500,000 cycles of operation. A cycle shall consist of one full line of print or a status change recording, whichever is greater. Replacement of ink, ribbons, or other renewable components is acceptable during the conduct of the test.

67.6 Audible signaling appliance

67.6.1 An audible signaling appliance integral with a product shall operate as intended when the product is operated for 8 hours of alternate 5-minute periods of energization and deenergization, followed by 72 hours of continuous energization. For this test, the product is to be connected to a source of rated voltage and frequency. For a battery-operated product, a filtered DC supply is to be used that has an output voltage equivalent to the fresh battery voltage.

68 Jarring Test

68.1 A product shall withstand jarring resulting from impact and vibration without:

a) Resulting in a risk of shock or fire hazard;

b) Causing false signaling operation of any part; and

c) Impairing the subsequent intended operation.

68.2 Product utilizing freestanding, desktop, or other non-wall- or ceiling-type mounting shall comply with the requirements in 68.1 when subjected to the jarring described in 68.4.

68.3 Products weighing less than 13.6 kg (30 lbs.) and utilizing wall or ceiling mount configurations shall comply with the requirements in 68.1 when subjected to the jarring described in 68.5. Products weighing 13.6 kg or more and utilizing wall or ceiling mount configurations shall comply with the requirements in 68.1 when subjected to the jarring described in 68.4 or 68.5. 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.

68.4 An impact of 4.08 J (3 foot-lb.) is to be applied directly to any nondisplay area of the product by means of a 535-g (1.18-lb.), 51-mm (2-inch) diameter steel sphere swung through a pendulum arc from a height (h) of 775 mm (2.54 feet). The at-rest suspension point of the steel sphere is to be 25.4 mm (1 inch) in front of the plane of the product to be impacted.

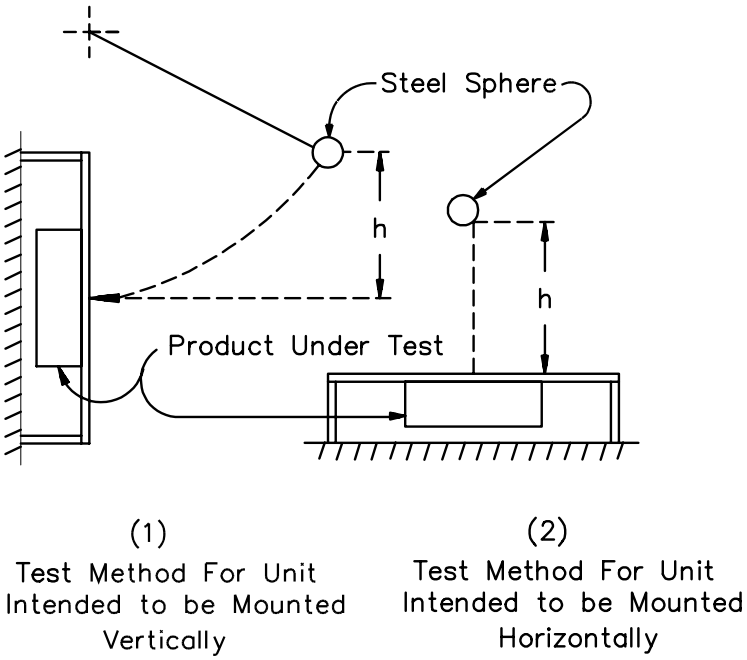
68.5 The product is to be mounted as intended to the center of a 1.8- by 1.2-m (6- by 4-foot) nominal 19.1-mm (3/4-inch) thick plywood board secured in place at four corners. A 4.08 J (3 foot-pound) impact is to be applied to the center of the reverse side of this board by means of a 535 g, 51-mm diameter steel sphere either:

a) Swung through a pendulum arc from a height (h) of 775 mm (2.54 feet) or

b) Dropped from a height (h) of 775 mm depending upon the mounting of the equipment.

See Figure 68.1.

Figure 68.1
Jarring test



68.6 During this test, the product shall be connected to a rated source of supply voltage and tested while in the normal supervisory condition.

69 Time-Limit Cutout Calibration Test

69.1 A notification-alarm circuit time-limit cutout shall operate within 10 percent of the set point when the circuit in which it is connected is energized continuously at its maximum rated current and when tested at an ambient temperature of 77 ±3.6°F (25 ±2°C).

70 Leakage Current Test

70.1 Where a cord-connected product is powered by a source greater than 42.4 volts 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 volts peak shall not be more than the following values when tested in accordance with 70.2 – 70.8:

a) 0.5 milliampere for an ungrounded (2-wire) portable or stationary;

b) 0.5 milliampere for a grounded (3-wire) portable product, and

c) 0.75 milliampere for a grounded (3-wire) stationary.

Exception: Where an electromagnetic radiation suppression filter is necessary for the product to function as intended, the leakage current is to not be more than 2.5 milliamperes when the product complies with the following conditions:

a) The product is provided with grounding means in accordance with the applicable requirements for a cord-connected product in Grounding for Products Containing High-Voltage Circuits, Section 24;

b) With the filter removed from the product, the leakage current does not exceed the limits specified in 70.1(b) and (c), as applicable; and

c) The product is marked in accordance with 89.1.9.

70.2 With regard to the requirements in 70.1, 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.

70.3 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 inch (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.

70.4 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 centimeters) in contact with the surface. Where the surface is less than 3.94 by 7.88 inches, 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.

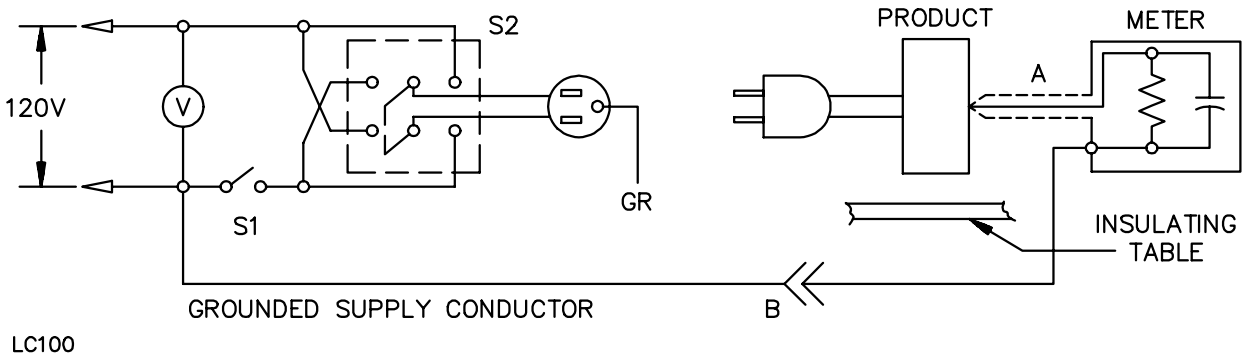
70.5 The measurement circuit for the leakage current test is to be as illustrated in Figure 70.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement need only indicate the same numerical value for the particular measurement as would the defined instrument. The meter is not required to have all of the attributes of the defined instrument.

a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad;

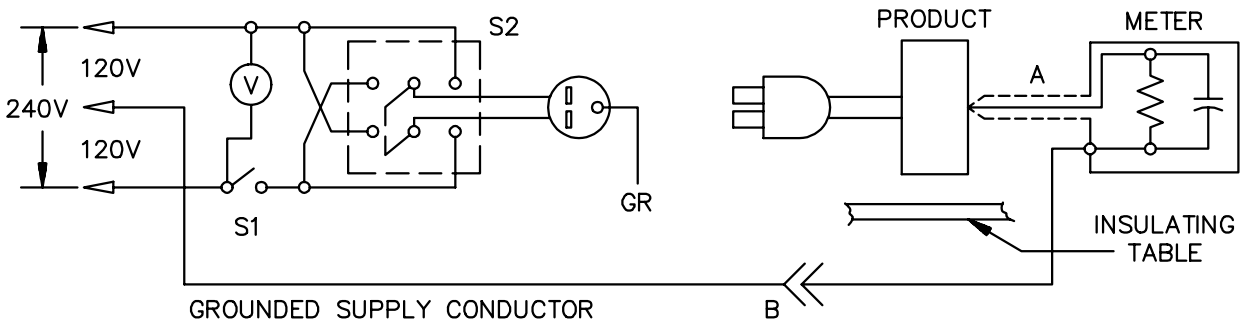
b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor;

c) Over a frequency range of 0 – 100 kilohertz, 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-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

Figure 70.1
Leakage current measurement circuits

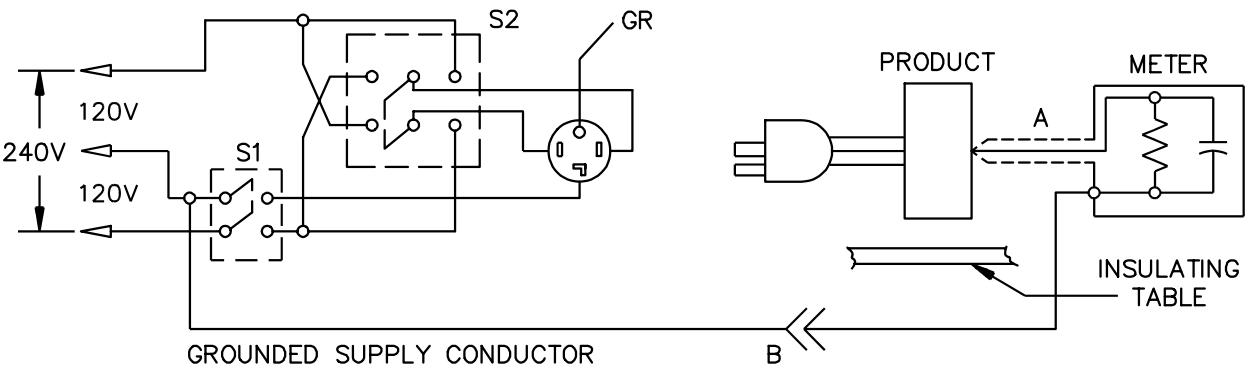


Product intended for connection to a 120-volt power supply.



LC200

Product intended for connection to a 3-wire, grounded neutral 120/240-volt power supply, as illustrated above.



LC300

Product intended for connection to a 3-wire, grounded neutral 120/240-volt power supply, as illustrated above.

A – probe with shielded lead.

B – Separated and used as clip when measuring currents from one part of product to another.

NOTE – 120/240 V circuit also apply to 208Y/120V supply.

70.6 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.

70.7 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.

70.8 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 hours 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 30.1.2 or shall be as described in 62.6, but not less than 120 or 240 volts. The test sequence (with regard to Figure 70.1) 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 seconds 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 Component Temperature Test, Section 62.

71 Transient Tests

71.1 General

71.1.1 While energized from a source of supply in accordance with Table 30.1, a product shall:

a) Not falsely annunciate alarms or troubles;

b) Not falsely actuate releasing device(s);

c) Not reset during an alarm condition;

d) Experience no electrical or mechanical failure of any components of the product;

e) Operate as intended following the test; and

f) As appropriate, retain required stored memory (such as date, type, and location of a signal transmission) within the unit;

when subjected to the tests described in 71.2.1 – 71.4.3.

Exception No. 1: Annunciation of a trouble signal that, either automatically restores or is manually resettable through the operator interface, is acceptable during the internally induced and field-wiring transient tests.

Exception No. 2: Supplemental information stored within the product is not required to be retained during any of the transient tests.

71.1.1 effective December 31, 2008

71.1.2 Products intended to interconnect to releasing devices shall be tested with each releasing device connected as specified in the installation wiring diagram/instructions.

71.1.2 effective December 31, 2008

71.2 Externally-induced supply-line transients

71.2.1 A product intended to be powered from commercial AC shall be subjected to supply line transients induced directly between the power supply circuit conductors of the equipment under test.

71.2.2 For this test, the product is to be connected to a transient generator capable of producing the transients described in 71.2.3.

71.2.3 The transients produced are to be oscillatory and are to have an initial peak voltage of 6000 volts. The rise time is to be less than 1/2 microsecond. Successive peaks of the transient are to decay to a value of not more than 60 percent of the value of the preceding peak at a rate of 100 kilohertz until line voltage is attained. Each transient is to have a total duration of 20 microseconds and is to be applied at the peak of the 60 hertz waveform.

71.2.4 The product is to be subjected to 500 transient pulses induced at a rate of 6 transients per minute. A total of 250 pulses are to be applied so that the transient is induced during the positive phase with reference to earth ground, and the remaining 250 pulses are to be induced during the negative phase with regard to earth ground. Of the total 250 pulses at each polarity, 225 are to be applied with the product in the normal supervisory condition and 25 are to be applied with the product in the alarm condition.

71.3 Internally-induced transients

71.3.1 The product is to be energized in the intended standby condition from a rated source of supply that is to be interrupted a total of 500 times. Each interruption is to be for approximately 1 second at a rate of not more than six interruptions per minute. The test is to be conducted for each different type of secondary power source configuration described in the installation document such as internal battery charging or connection to a separate battery charger. Where the system configuration involves two or more products, each with their own AC input, the test is to be conducted by momentarily interrupting the input to all products simultaneously.

71.3.1 effective December 31, 2008

71.4 Input/output (low-voltage) field-wiring transients

71.4.1 The product is to be energized in the normal standby condition while connected to a source of supply in accordance with Table 30.1. All field-wiring circuits are to be tested as specified in 71.4.2 and 71.4.3.

Exception: A circuit or cable that interconnects equipment located within the same room is not required to be subjected to this test.

71.4.2 For this test, each output circuit is to be subjected to the transient waveforms specified in the following table, as delivered into a 200-ohm load. The transient pulses are to be coupled directly onto the output circuit conductors of the equipment under test.

Peak voltage level, V	Minimum energy level, J	Minimum pulse duration, µs	Figure No.
2400	1.0	80	71.1
1000[a]	0.31	150	71.2
500[a]	0.10	250	71.3
100	0.011	1120	71.4

[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 71.5) and minimum energy level (Figure 71.6) parameters, and shall have an equal or faster minimum transient pulse rise time than that specified in Figure 71.7.

Figure 71.1
Signal line transients – 2400V curve

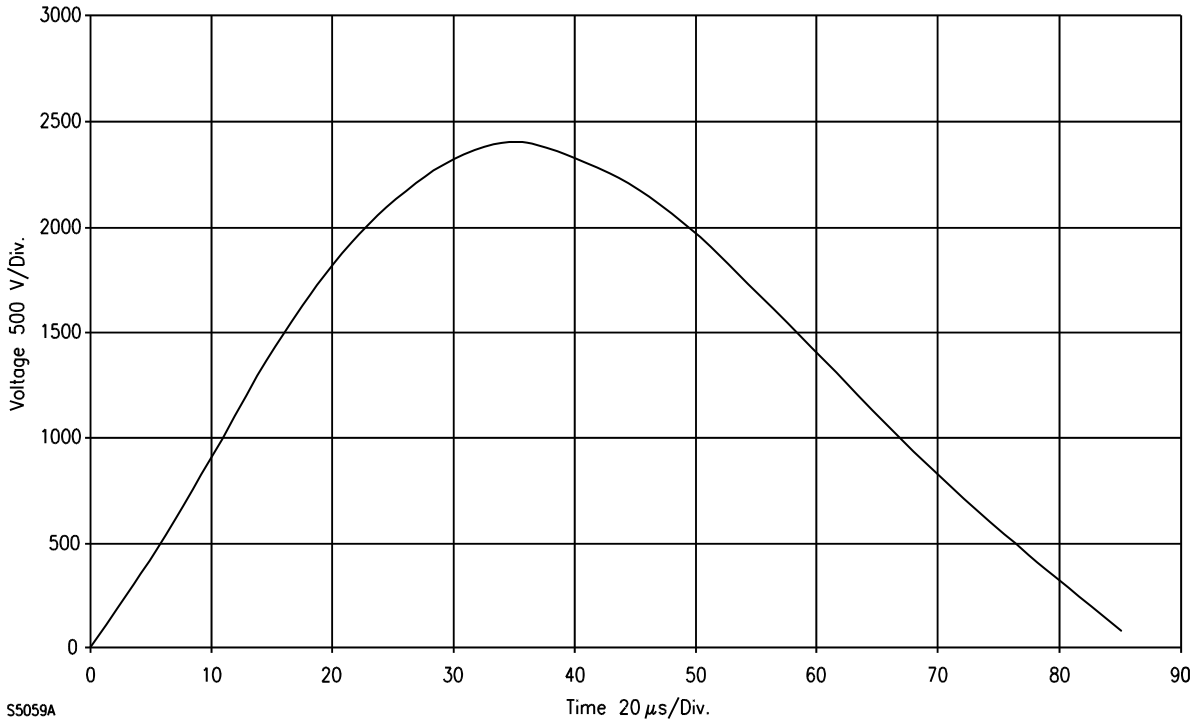


Figure 71.2
Signal line transients – 1000V curve

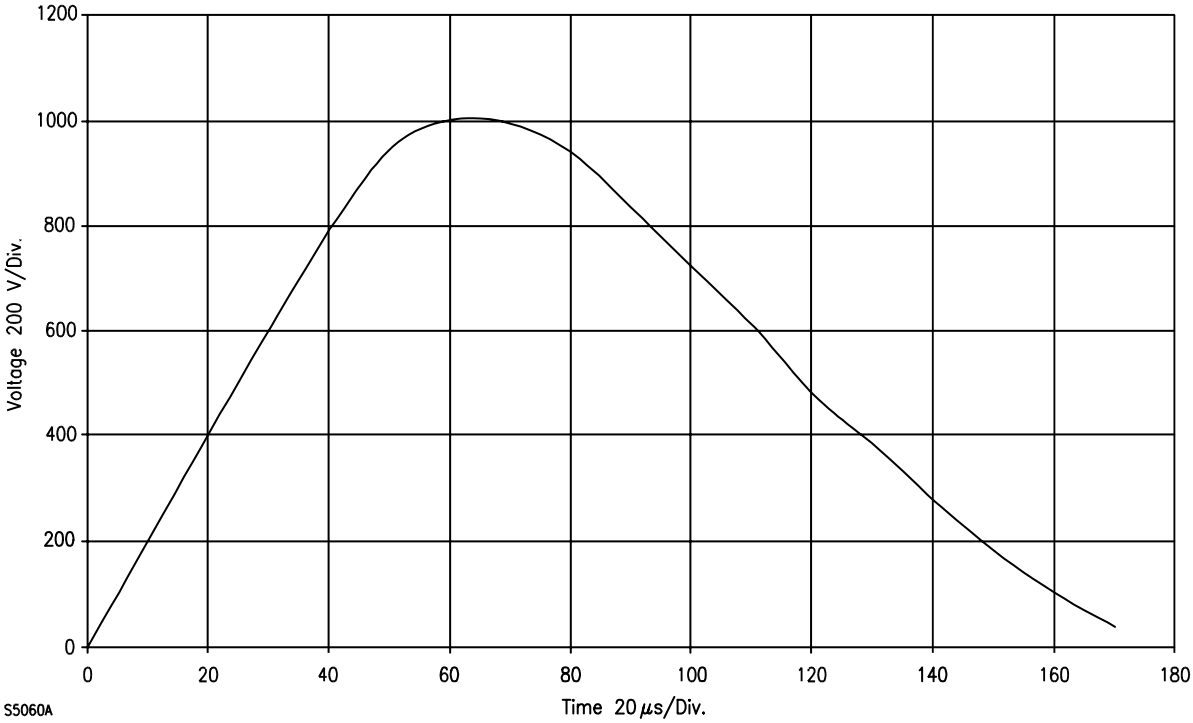


Figure 71.3
Signal line transients – 500V curve

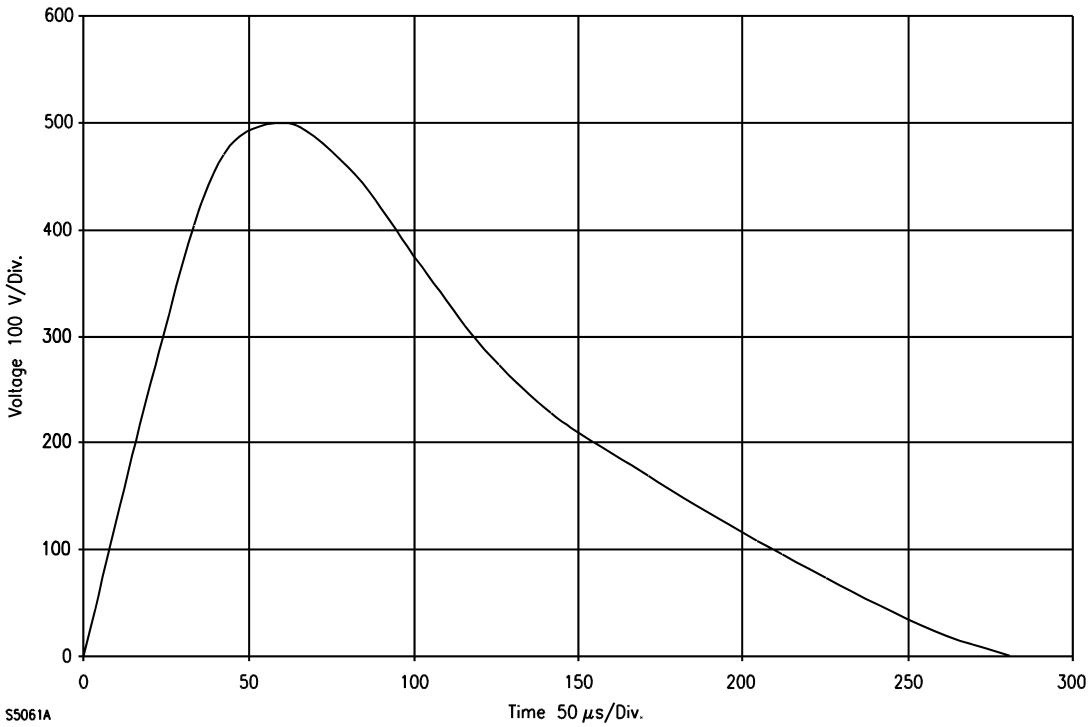


Figure 71.4
Signal line transients – 100V curve

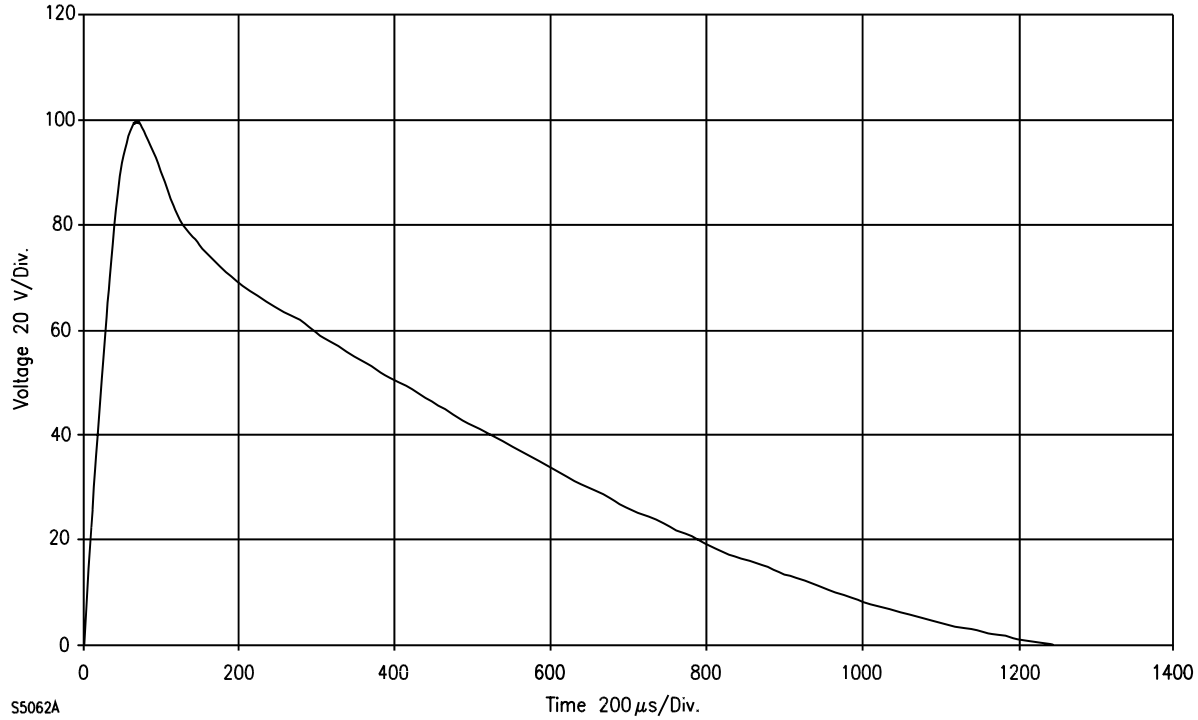


Figure 71.5
Minimum transient pulse duration vs. transient peak voltage

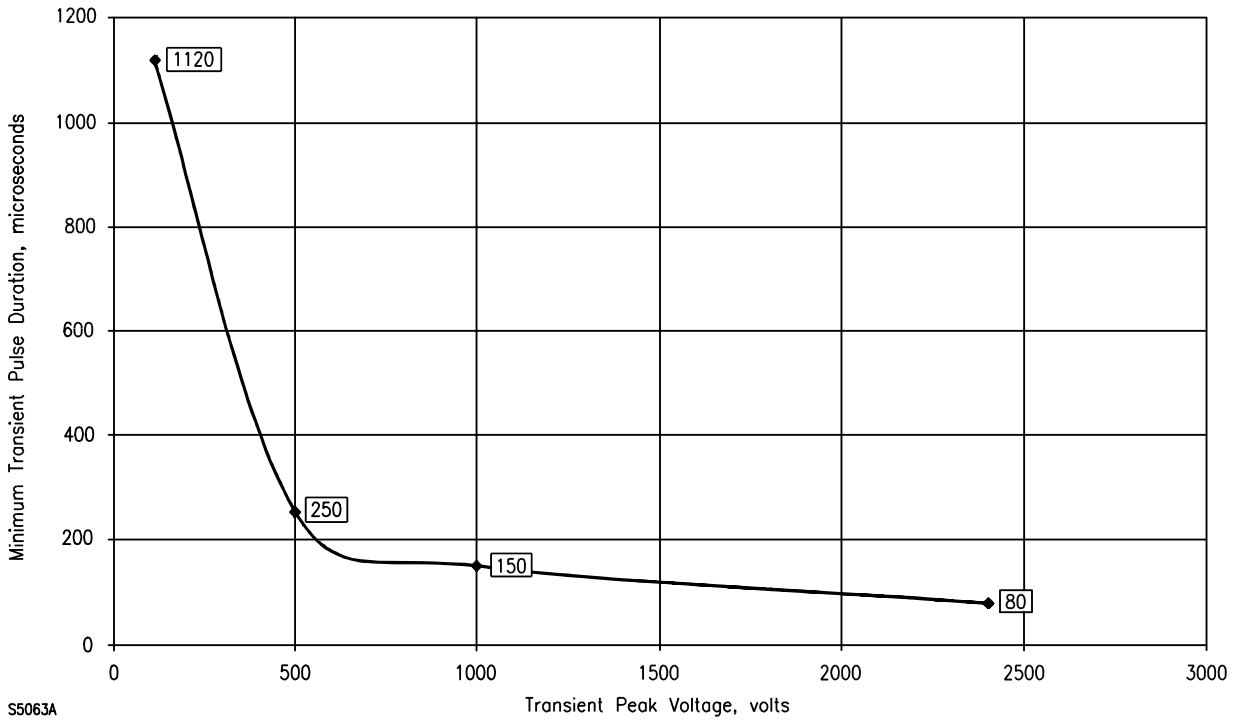


Figure 71.6
Minimum transient energy level vs. transient peak voltage

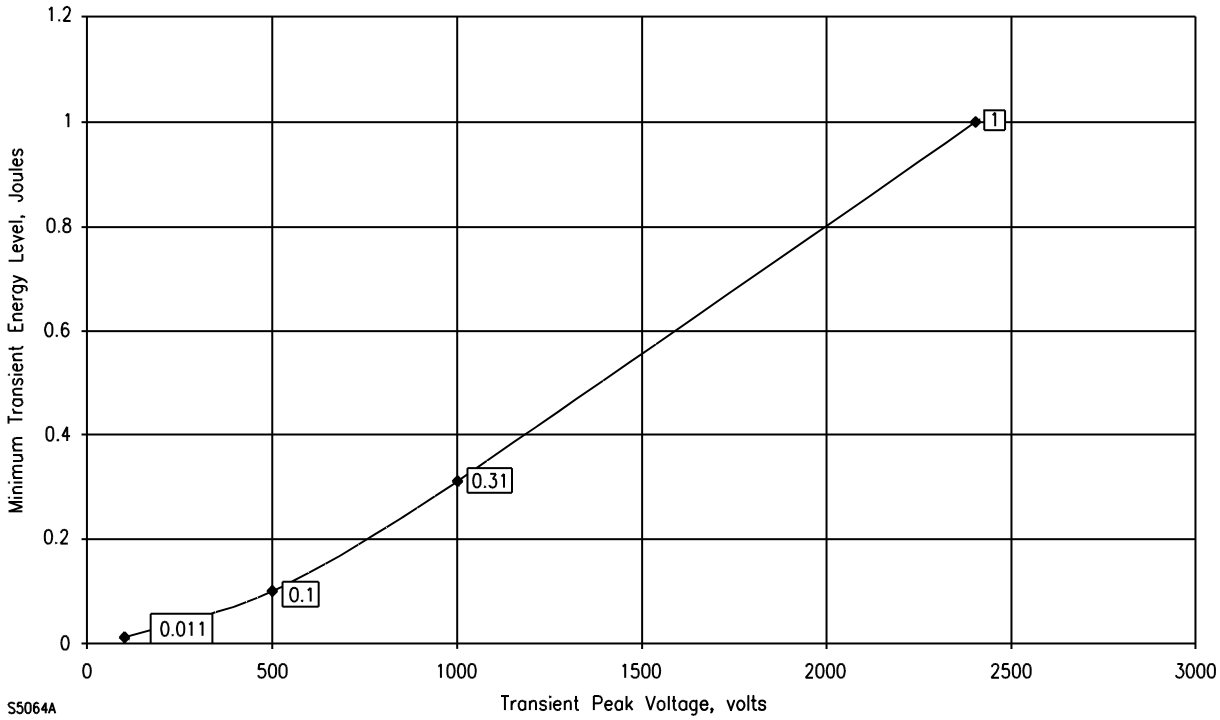
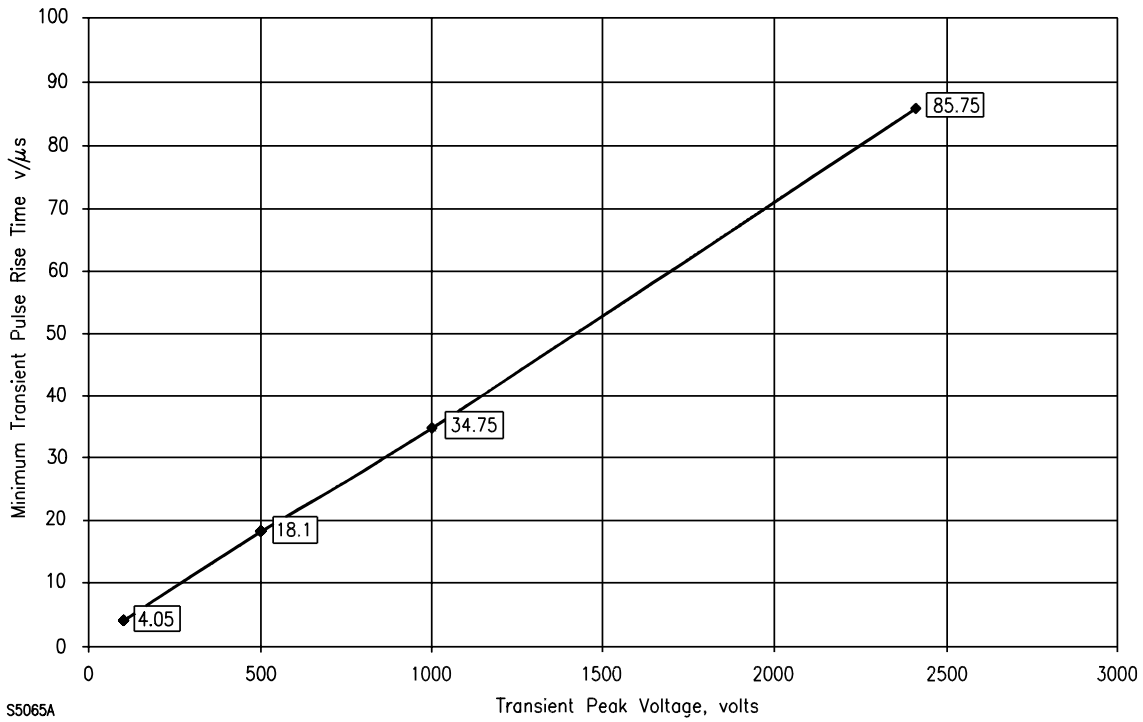


Figure 71.7
Minimum transient pulse rise time vs. transient peak voltage



71.4.3 Each conductor of a circuit is to be subjected to 40 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 71.4.2) between each lead or terminal and earth ground, consisting of ten pulses of one polarity, and ten of the opposite polarity and

b) Twenty pulses (four at the 2400 peak voltage level and two at each of the other transient voltage levels specified in 71.4.2) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten pulses of the opposite polarity.

72 Electric Shock Current Test

72.1 Electric shock current refers to all currents, including capacitively coupled currents.

72.2 When the open circuit potential between any part that is exposed only during user servicing (see 25.2.1) and either earth ground or any other exposed accessible part exceeds 42.4 volts peak, the part shall comply with the requirements in 72.3 – 72.7, as applicable.

72.3 With reference to the requirements in 72.2, parts are determined to be simultaneously accessible when 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 determined to be able to contact simultaneously parts within a 4 by 8 inch (102 by 203 mm) rectangle, and two hands of a person are determined to be able to contact parts simultaneously when the parts are not more than 6 feet (1.8 m) apart.

72.4 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 72.1 when the resistor is connected between the exposed part and, either earth ground or any other exposed accessible part, or all exposed parts collectively when the parts are simultaneously accessible.

Table 72.1
Maximum current during operator servicing

Frequency, hertz[a]	Maximum measured current through a 500-ohm resistor, mA
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.

72.5 The duration of a transient current flowing through a 500-ohm resistor connected as described in 72.4 shall not exceed 809 amperes, regardless of duration, and 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 milliamperes and the time that the current falls below 7.1 milliamperes for the last time and

I is the peak current in milliamperes.

The interval between occurrences shall be equal to or greater than 60 seconds when the current is repetitive. Typical calculated values of maximum measured transient current duration are shown in Table 72.2.

Table 72.2
Maximum transient current duration

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes 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
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

Table 72.2 Continued on Next Page

Table 72.2 Continued

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak
809.0	8.3

72.6 The maximum capacitance between the terminals of a capacitor that is accessible during user servicing shall comply with the following equations:

$$C = \frac{88{,}400}{E^{1.43}(\ln E - 1.26)} \quad for \quad 42.4 \leq E \leq 400$$

$$C = 35{,}288E^{-1.5364} \quad for \quad 400 \leq E \leq 1000$$

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 similar structure).

Typical calculated values of maximum capacitance are shown in Table 72.3.

Table 72.3
Electric shock – stored energy

Potential in volts, across capacitance prior to discharge	Maximum capacitance in 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

Table 72.3 Continued on Next Page

Table 72.3 Continued

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
260	7.24
240	8.27
220	9.56
200	11.2
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
42.4	169.0

72.7 Current measurements are to be made with any operating control (or adjustable control that is subject to user operation) in all operating positions, and either with or without a separable connector or similar component in place. These measurements are to be made with controls placed in the position that causes maximum current flow.

73 Ignition Test Through Bottom-Panel Openings

73.1 The bottom-panel constructions described in 6.9.1 – 6.9.3 are permitted without testing. Other constructions can be used when they comply with the test described in 73.2 – 73.5.

73.2 Openings in a bottom panel shall be arranged and sufficiently small in size and few in number so that hot flaming No. 2 furnace oil poured three times onto the openings from a position above the panel is extinguished as it passes through the openings.

73.3 A sample of the complete, finished bottom panel is to be supported in a horizontal position a short distance above a horizontal surface under a hood or in another area that is ventilated but free from drafts. Bleached cheesecloth running 14 – 15 yd^2/lb mass (26 – 28 m^2/kg mass) and having what is known to the trade as ″a count of 32 by 28″ (a square 1 inch on a side has 32 threads in one direction and 28 in the other or square 1 centimeter on a side has 13 threads in one direction and 11 in the other), is to be draped in one layer over a shallow flat-bottomed pan that is of a size and shape to cover completely the pattern of openings in the panel but is not sufficiently large to catch any of the oil that runs over the edge of the panel or otherwise does not pass through the openings. The pan is to be centered under the center of the pattern of openings in the panel. The center of the cheesecloth is to be 2 inches (50 mm) below the openings. Use of metal screen or wire-glass enclosure surrounding the test area is recommended to keep splattering oil from causing injury to persons.

73.4 A small metal ladle not more than 2-1/2 inches (65 mm) in diameter, with a pouring lip and a long handle whose longitudinal axis remains horizontal during pouring, is to be partially filled with 0.34 ounces (10 cm^3 or 10 ml) of No. 2 fuel oil, which is a medium-volatile distillate having a minimum API gravity of 30 degrees, a flash point of 110 – 190°F (43.3 – 87.7°C), and an average calorific value of 136,900 Btu/gal (38.2 MJ/L); see the Standard Specification for Fuel Oils, ASTM D396. The ladle containing the oil is to be heated and the oil is to be ignited. The oil is to flame for 1 minute and then is to be poured at the approximate rate of, but not less than 0.034 ounces (1 cm^3/s or 1 mL/s) in a steady stream onto the center of the pattern of openings from a position 4 inches (100 mm) above the openings. It is to be observed whether the oil ignites the cheesecloth.

73.5 Five minutes after completion of the pouring of the oil, the cheesecloth is to be replaced with a clean piece and a second 0.34-ounce (10-cm^3 or 10-mL) ladle of hot flaming oil is to be poured onto the openings, again to be observed whether the cheesecloth is ignited. Five minutes later, a third identical pouring is to be made. The openings do not comply with the requirement in 73.1 if the cheesecloth is ignited during any of the three pourings.

74 Dielectric Voltage-Withstand Test

74.1 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, between live parts and exposed dead-metal parts (see 74.2), and between live parts of circuits operating at different potentials or frequencies (see 74.3). The test potential is to be:

a) For circuits rated 30 volts AC rms (42.4 volts DC or AC peak) or less – 500 volts AC (707 volts, when a DC potential is used);

b) For circuits rated greater than 30 and equal to or less than 150 volts AC rms (42.4 and 212 volts DC) – 1000 volts AC (1414 volts, when a DC potential is used);

c) For circuits rated more than 150 volts AC rms (212 volts DC) – 1000 volts AC plus twice the rated voltage (1414 volts plus 2.828 times the rated AC rms voltage, when a DC potential is used).

See 74.4 – 74.6.

74.2 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.

74.3 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 74.1(a), (b), or (c), based on the highest voltage of the circuits under test. Electrical connections between the circuits are to be disconnected before the test potential is applied.

74.4 Where 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 capacitor or filter is to be tested using a DC test potential in accordance with 74.1.

74.5 The test potential shall 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 percent 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 seconds and then

b) Maintained at the test potential for 1 minute without an indication of a breakdown or leakage of greater than 0.5 mA.

Manual or automatic control of the rate of rise is not prohibited.

74.6 A printed-wiring assembly or other electronic circuit component that is capable of short-circuiting (or being damaged by) the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. A representative subassembly is then to be tested instead of an entire unit.

75 Abnormal Operation Tests

75.1 General

75.1.1 When the conditions of intended operation are not representative of all conditions possible in service, a product shall not present a risk of fire, electric shock, or injury to persons when operated under such abnormal conditions.

75.1.2 Continuous operation, malfunction of components, shorting of output circuits, failure of cooling fans, and likely misuses of the product are examples of conditions to be simulated during the tests in this section.

75.1.3 During the tests, a single layer of bleached cheesecloth, fabricated at 14 – 15 square yards to the pound (26 – 28 m^2/lb) and having a thread count of 28 by 32, is to be draped loosely over the entire unit. The product is to be connected to a power supply as indicated in 30.1.2 and connected in series with a non-time-delay fuse of the maximum current rating of the branch circuit. Opening of the fuse before any condition of risk of fire or electrical shock results is considered as meeting the intent of the requirements. The enclosure, when metallic or employing dead-metal parts, shall be connected to ground either through a fuse rated to correspond to the input rating of the unit or 3 amperes, whichever is less. Only one abnormal condition is to be simulated at a time.

75.1.4 During these tests, all fuses which are field-renewable by the user and are of an interchangeable type shall be replaced by a fuse of the same size and voltage rating using the highest available current rating for that size. Opening of the fuse before any condition of risk of fire or electrical shock results satisfies the requirement of the test.

Exception: Fuses need not be replaced when the product employs marking identifying the need for using the indicated fuse(s) located so that it is obvious as to which fuse or fuseholder(s) the marking applies and where readily visible during replacement of the fuse(s). A single marking is acceptable for a group of fuses. The marking shall comply with 89.1.24 and shall consist of the word "CAUTION" and the following or equivalent text: "For continued protection against risk of fire, replace only with same type and rating of fuse".

75.1.5 All abnormal conditions are to be continued until ultimate results are obtained, such as burnout or stabilization of temperatures.

75.1.6 Compliance with the tests specified in this section is met when all of the following occurs:

a) There is no ignition or charring of the cheesecloth indicator (charring is deemed to have occurred when the structural integrity of the threads has been destroyed due to the temperature rise);

b) The fuse from the enclosure to ground does not open;

c) Immediately following these tests, the product complies with:

1) The Dielectric Voltage-Withstand Test, Section 74, within 1 minute of the conclusion of the test, or

2) The Leakage Current Test, Section 70, when it is not practical to conduct the dielectric voltage-withstand test due to numerous components electrically connected to the product chassis or ground.

75.1.6 revised July 14, 2005

75.2 Operation

75.2.1 A product that normally would only be operated for a limited time shall be capable of operating continuously in any condition of normal use possible without risk of fire, electric shock, or injury to persons.

75.3 Field-wiring circuits

75.3.1 Each output circuit of the product to which field wiring is intended to be connected is to be individually opened or shorted.

75.3.2 The test condition in 75.3.1 shall be applied one at a time. The abnormal condition shall be introduced while the equipment is operating in any condition of normal use.

75.4 Electronic components

75.4.1 Capacitors not determined a reliable component as specified in 53.2, shall additionally comply with the conditions specified in 75.1.1 – 75.1.6 when individually opened and shorted.

75.4.1 effective December 31, 2008

75.4.2 All circuit components located in a high-voltage circuit shall be examined using the equipment circuit diagrams and component specifications to determine those faults that can occur. Examples are short-circuits and open-circuits of transistors, rectifiers, diodes, and capacitors, faults causing continuous dissipation in resistors designed for intermittent dissipation, and internal faults in integrated circuits causing excessive dissipation. The product shall then be operated during each of the fault conditions until constant temperature or burnout occurs.

Exception: Components do not require testing when located in circuits meeting one of the following conditions:

a) Where the circuit current is limited by 10,000 ohms or more of series impedance in a circuit in which the voltage is 125 V or less;

b) Where the circuit current is limited by 20,000 ohms or more of series impedance in a circuit in which the voltage is greater than 125 V but is not greater than 250 V;

c) When the power source supplying the circuit is power limited as specified in Table 60.1 or 60.2; or

d) Circuits or devices that have been evaluated for use in high-voltage circuits, such as EMI Line Filters.

75.4.2 effective December 31, 2008

75.4.3 The faults referenced in 75.4.2 shall be applied one at a time. Short circuits shall be applied only between two terminals of a multi-terminal device at one time. Simulated circuits are also capable of being used for high-voltage circuit abnormal tests. But when the tests performed on simulated circuits indicate likely damage to other parts of the equipment to the extent that the safety of the equipment is capable of being affected, the tests shall be repeated in the equipment. The abnormal condition shall be introduced while the equipment is operating under intended conditions. This is to be accomplished by jumper leads and remote switches with consideration given to the effect these devices have on the test.

75.4.3 effective December 31, 2008

75.4.4 Component burnout shall not be used as the sole means of preventing a risk of fire or shock.

75.4.4 effective December 31, 2008

75.5 Cooling fans and blowers

75.5.1 The product shall be operated under the condition which produces the greatest power dissipation until constant temperature or burnout occurs with all cooling fans and blowers disabled.

75.5.2 The locked-rotor test is to be conducted on the product and operated with the rotor of each cooling fan and blower motor locked.

Exception: Where a means of limiting the current is inherent in or provided as part of the device, these features are to be given consideration when conducting the locked-rotor test. These features may be external to the fan or motor and include, but are not limited to, the following:

a) Nonresettable thermal elements that are integral with fan or motor windings;

b) Wire-wound, or other types of resistors that limit the load current;

c) Positive temperature coefficient (PTC) resistors;

d) Inherent limitation due to impedance of the fan or motor windings; and

e) Nonreplaceable fusing elements soldered into the product.

75.5.3 When the fan or motor indicated in 75.5.2 is connected directly to the branch circuit a circuit representing the branch circuit supplying the motor or fan under test is to be protected by a circuit breaker rated at least ten times the primary current rating of the fan or motor, but not less than 15 amps. Opening of the circuit breaker is acceptable when the installation instructions for the product specifies the maximum overcurrent protection rating to be used for the branch circuit.

75.6 Transformer burnout

75.6.1 A transformer shall be operated under one of the following conditions:

a) A transformer supplying a low-voltage circuit shall be tested with the secondary circuit shorted.

b) A power transformer supplying a high-voltage circuit shall be tested with the secondary circuit shorted or while connected to a resistive load drawing three times the full rated current, whichever results in the greater current value.

Exception: Where a means of limiting the secondary circuit current is inherent in or provided as part of the device, these features are to be given consideration and the burnout test conducted at the maximum load permitted by the limiting features. These features may be external to the transformer and include, but are not limited to, the following:

a) Nonresettable thermal elements that are integral with transformer windings;

b) Wire-wound, or other types of resistors that limit the load current;

c) Positive temperature coefficient (PTC) resistors;

d) Inherent limitation due to impedance of the transformer windings; and

e) Non-replaceable fusing elements soldered into the product.

75.6.2 A circuit representing the branch circuit supplying the transformer under test is to be protected by a circuit breaker rated at least ten times the primary current rating of the transformer, but not less than 15 amps. Opening of the circuit breaker is acceptable when the installation instructions for the product specifies the maximum overcurrent protection rating to be used for the branch circuit.

75.6.3 The test shall be conducted until constant temperature or burnout occurs.

75.7 Communications circuits

75.7.1 Where a product has provisions for connection to a telephone, telegraph, or 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 Safety of Information Technology Equipment, UL 60950.

75.7.1 revised July 14, 2005

76 Tests on Special Terminal Assemblies

76.1 General

76.1.1 To determine its suitability as a field-wiring connection in compliance with 12.5.1 and 12.5.2, representative samples of the terminal assembly shall comply with all of the tests specified in 76.2.1 – 76.5.2.

76.2 Mechanical secureness test

76.2.1 A terminal connection shall withstand the application of a straight pull of 5 pounds (22.2 N), applied for 1 minute to the wire in the direction which would most likely result in pullout, without separating from the terminal.

76.2.2 Six samples of the terminal are to be connected to the wire sizes with which they are intended to be used, in accordance with the manufacturers instructions. When a special tool is required to assemble the connection, it is to be used. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 5 pounds (22.2 N) is reached.

76.3 Flexing test

76.3.1 The wire attached to a terminal shall be capable of withstanding an average of 5 right-angle bends without breaking.

76.3.2 Six terminal assemblies using the maximum wire size and six with the minimum wire size shall be subjected to this test. The terminal shall be rigidly secured so as to prevent any movement. With the wire in 3-pound (1.4-kg) tension and held at a point 3 inches (76.2 mm) from the terminal-to-wire juncture, the wire shall be bent at a right angle from the nominal wire position. The wires shall be assembled to the terminals using any special tool required as specified in the manufacturer's instructions. The tension on the wire shall be sufficient to hold the wire in a rigid position during the flexing trials.

76.4 Millivolt drop test

76.4.1 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 of the circuit flowing through the terminal connection at the rated voltage of the circuit.

76.4.2 Six terminal assemblies using the maximum wire sizes and six assemblies using the minimum wire sizes shall be subjected to this test. The wires shall be assembled to the terminals using any special tool, when required, according to the manufacturer's instructions. The millivolt drop shall then be measured using a high-impedance millivoltmeter with the maximum current, as specified by the manufacturer, flowing through the connection.

76.5 Temperature test

76.5.1 The maximum temperature rise on a terminal junction with the maximum or minimum wire sizes with which the terminal is used, shall not be greater than 86°F (30°C) based on an ambient temperature of 77°F (25°C).

76.5.2 Six terminal assemblies using the maximum wire size and six using the minimum wire size are to be subjected to this test. The wire is to be assembled to the terminals using any special tools, when required, according to the manufacturer's instructions. The maximum current is then to be passed through the terminal connection to which the wire will be subjected in service. After temperatures have stabilized, the maximum temperature rise is to be measured by the thermocouple method in accordance with the Component Temperature Test, Section 62.

77 Mechanical Strength Test for Metal Enclosures and Guards

77.1 The enclosure or guard of a unit, when of metal, shall withstand a force of 100 pounds for 1 minute, applied by means of a hemisphere, 1/2-inch (12.7 mm) in diameter, and an impact of 5 foot-pounds (7 N·m), applied by means of a smooth, solid, steel sphere 2 inches (50.8 mm) in diameter and having approximately 1.18 pound (0.54 kg) mass. The sphere is to fall freely from rest through a vertical distance of 51 inches (1.3 m) or swung through a pendulum arc of 51 inches as shown in Figure 77.1 without:

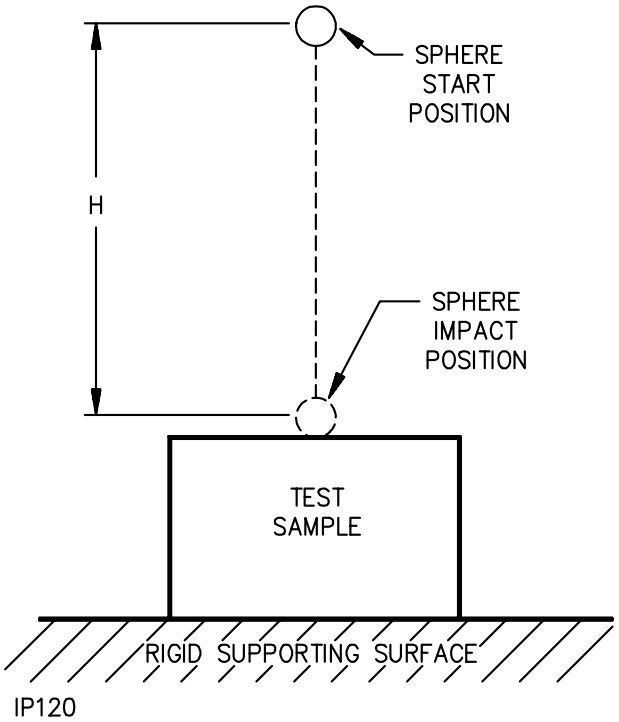
a) Permanent distortion to the extent that spacings are reduced more than 50 percent of the values specified in Spacings, Section 16;

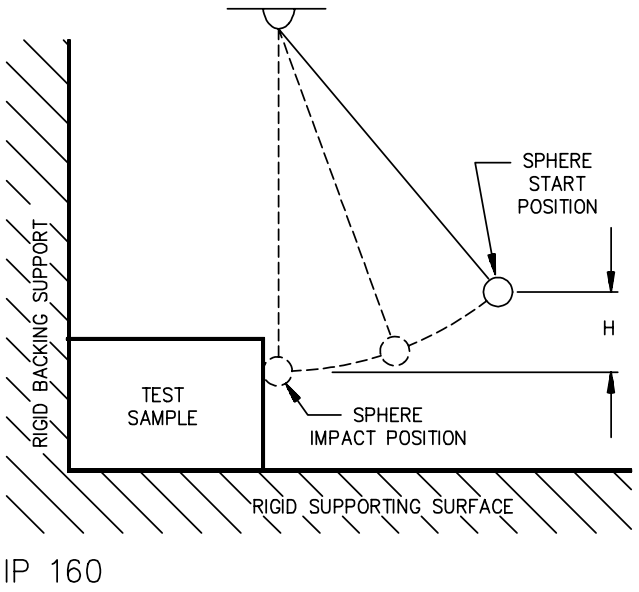
b) Transient distortion that results in a reduction of more than 50 percent of the values specified in Section 16; and

c) Developing openings that do not comply with the requirements in Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section 8.

Exception: Mechanical strength tests are not required for enclosures complying with the thickness requirements in 6.2.1 and Tables 6.1 – 6.3.

Figure 77.1
Ball pendulum impact test





NOTES

1) H is the vertical distance of 51 inches (1.3 m).

2) For the ball pendulum impact test, the sphere is to contact the test sample when the cord is in the vertical position as shown.

78 Radio Frequency Interference Test

78.1 A product shall not false alarm or release, or have its intended operation be impaired during exposure to radiating radio-frequency sources generated by the devices and appliances described in 78.3.

78.1 effective December 31, 2008

78.2 To determine compliance with 78.1, the product is to be energized from a source of rated voltage and frequency, interconnected as described in the installation wiring diagram/instructions, and subjected to the radio-frequency interference generated from the transceivers described in 78.3. Products intended to be connected to releasing devices shall have each device connected during the test.

78.2 effective December 31, 2008

78.3 The radio-frequency interference sources for the nominal frequencies specified in (a) – (d) are to be 5-watt radio transmitters, using random voice messages, whose antennas are placed 30 cm from the nearest edge of the product under test. The radiating antennas shall be 1/4-wave monopole. The test is to be conducted with each antenna tip pointed directly at the product, and repeated with the antenna at a right angle to the first position, centered on the product. The transmitter is to be in the same room as the product under test.

a) 27 megahertz;

b) 150 megahertz;

c) 450 megahertz;

d) 866 megahertz; and

e) 910 megahertz.

A total of six energizations in each of the two orientations are to be applied for each nominal frequency, five to consist of 5 seconds on and 5 seconds off, followed by one consisting of a single 15-second energization.

78.3 effective December 31, 2008

79 Short-Range Radio Frequency (RF) Devices Test

79.1 General

79.1.1 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.

79.1.1 effective December 31, 2008

79.1.2 These requirements are applicable to systems using initiating device transmitters, repeater transceivers (optional) and receiver units with the transmitters operating on a random basis or using two-way interrogate/response signaling.

79.1.2 effective December 31, 2008

79.2 Reference level determination

79.2.1 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.

79.2.1 effective December 31, 2008

79.2.2 For the purpose of these requirements, the minimum signal strength required for normal operating performance is designated as the reference signal level. The ambient radio-frequency noise level that would affect normal operating performance is designated as the maximum ambient noise level (see 51.5.12).

79.2.2 effective December 31, 2008

79.2.3 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 79.2.1) 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.

79.2.3 effective December 31, 2008

79.3 Interference immunity

79.3.1 A receiver/transmitter combination at the minimum reference signal level shall operate for its intended signaling performance in the noise environment described in 79.3.2.

79.3.1 effective December 31, 2008

79.3.2 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. This condition is intended to test the receiver's ability to discriminate the desired signal from background noise under worse-case conditions.

79.3.2 effective December 31, 2008

79.3.3 The noise environment is to be created by a white-noise generator modulating an RF signal generator in which the frequency is varied by 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 79.2.1). The interference is to either emanate from a tuned 1/2 wave dipole antenna, capable of 360 degrees rotation in order to vary the polarization, or be injected into the product via a shielded electrical connection.

79.3.3 effective December 31, 2008

79.3.4 Operation of the receiver/transmitter combination shall comply with the requirements in 79.7.1 – 79.7.3 and 79.8.1 and 79.8.2, while in the noise environment.

79.3.4 effective December 31, 2008

79.4 Frequency selectivity

79.4.1 Where a product utilizes multiple frequencies, a receiver shall not respond to any signal having:

a) A signal strength 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, when the communication channel is 5 megahertz wide, any signal with a similar band width, even one with identical coding, the receiver shall ignore the center frequency of which is shifted by more than 10 megahertz.

79.4.1 effective December 31, 2008

79.4.2 A receiver is to be connected to a source of rated supply and is to be positioned for intended use.

79.4.2 effective December 31, 2008

79.4.3 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 in the manner specified in 79.4.1. The receiver shall not provide an output to any signal so transmitted.

79.4.3 effective December 31, 2008

79.4.4 This test is to be conducted for frequencies above and below the receiver frequency, including at least ten additional frequencies randomly selected about the center frequency (0.5 MHz – 1.024 GHz) and outside the frequency as specified in 79.4.1.

79.4.4 effective December 31, 2008

79.4.5 The test is to be monitored by a spectrum analyzer or other instrument that has been determined to be acceptable to verify transmitter output.

79.4.5 effective December 31, 2008

79.4.6 For test purposes, where the operating frequency or signal level 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 that modulates the RF signal generator output, when similar signal levels are generated at the receiver.

79.4.6 effective December 31, 2008

79.5 Clash

79.5.1 For the purpose of these requirements, clash is a loss of signal information at the receiver as a result of two or more transmitters being concurrently activated when only one is in off-normal mode so that their transmitted signals interfere with each other.

79.5.1 effective December 31, 2008

79.5.2 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.

79.5.2 effective December 31, 2008

79.5.3 The clash rate relative to normal status transmissions for each specific signal shall not exceed the following values:

a) 99.99 percent probability that the time between the initiation of a single alarm signal until it is received at the receiver does not exceed 10 seconds;

b) 99.95 percent probability that the time between the initiation of a single supervisory signal until it is received at the receiver unit does not exceed 10 seconds;

c) 99.95 percent probability that the time between the initiation of a single trouble signal until it is received at the local monitoring unit does not exceed 200 seconds.

79.5.3 effective December 31, 2008

79.5.4 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 79.5.3 (a) – (c), each specified factor is to be considered in the evaluation.

79.5.4 effective December 31, 2008

79.6 Clash error

79.6.1 For the purpose of this requirement, “clash error” is defined as the misinterpretation by the receiver of two simultaneous or overlapping valid transmitter signals that results in the receiver locking-in and annunciating a third (false) signal.

79.6.1 effective December 31, 2008

79.6.2 A receiver shall demonstrate a zero clash error rate while subjected to the test conditions described in 79.6.3 – 79.6.5.

79.6.2 effective December 31, 2008

79.6.3 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 AC supply or by a DC power supply in place of a primary battery, are to be adjusted such that the reference signal level described in 79.2.3 is present at the receiver. The address of each transmitter shall be set such that the logical “or” of the two addresses is a valid address recognized by the receiver.

79.6.3 effective December 31, 2008

79.6.4 One transmitter is to then be conditioned for continuous alarm transmission. The other transmitter shall be conditioned to transmit an alarm signal at a rate equal to twice the alarm message length for a total of 100,000 transmissions.

79.6.4 effective December 31, 2008

79.6.5 The test described in 79.6.3 and 79.6.4 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 signal at a rate equal to twice the normal supervisory message length for a total of 100,000 transmissions.

79.6.5 effective December 31, 2008

79.7 Error (falsing) rate

79.7.1 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 signals are not accepted by the receiver as valid status indications from the various transmitters in the system.

79.7.1 effective December 31, 2008

79.7.2 As a measure of compliance with 79.7.1, 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 79.2.3.

c) A counter is to be connected to the transmitter to record the number of transmissions. The arrangement is not to interfere with the transmitter output.

d) The transmitter is to be conditioned for continuous transmissions of:

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 79.1. 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.

79.7.2 effective December 31, 2008

Table 79.1
Error (falsing) rate test

Table 79.1 effective December 31, 2008

Number of incorrect elements per message	Message completed	Maximum number of incorrect messages accepted as valid
1	1,000,000	2
2	1,000,000	1
3	100,000	0

79.7.3 The test is to be conducted in the noise environment described in 79.3.1 – 79.3.4.

79.7.3 effective December 31, 2008

79.8 Throughput rate

79.8.1 For the purpose of this requirement, the throughput rate is a measure of the ability of a receiver to accurately interpret and execute upon receipt of a correct signal in order to achieve a high degree of assurance that alarm or emergency signals are not lost. The transmitter/receiver combination shall be structured so that alarm or emergency signals take precedence over all other signals.

a) The prioritization may be achieved by:

1) Extending the duration of the signal,

2) Repeating the alarm signal, or

3) Any other means that can be demonstrated to be equivalent.

b) When multiple services are utilized on the same system, the priority levels of signals shall be:

1) Signals associated with life safety,

2) Signals associated with property safety,

3) Supervisory or trouble signals, and

4) All other signals.

79.8.1 effective December 31, 2008

79.8.2 The throughput rate of the receiver is to be determined by utilizing the test procedure described in 79.7.1 – 79.7.3, except that only correct signals of each type are to be transmitted. The test results shall comply with Table 79.2. The test may be terminated after 100,000 cycles rather than 1,000,000 if the test results comply with the 100,000 signals completed row in Table 79.2.

79.8.2 effective December 31, 2008

Table 79.2
Throughput rate test

Table 79.2 effective December 31, 2008

Type of signal	Signals completed	Maximum number of missed signals in test conditions
Fire	100,000	4
	1,000,000	50
Trouble or supervisory	100,000	19
	1,000,000	200
Other	100,000	38
	1,000,000	400

79.9 Transmitter stability tests

79.9.1 While subjected to the environmental conditions indicated below, the transmitter/receiver combination shall complete 500 alarm transmissions as specified in 79.8.1 and 79.8.2, without a signal being missed.

a) 32 ±3 °F (0 ±2°C) for 3 hours;

b) 120 ±3 °F (49 ±2°C) for 3 hours; and

c) 93 ±2 percent relative humidity at 90 ±3°F (32 ±2°C) for 24 hours.

79.9.1 effective December 31, 2008

79.10 Transmitter accelerated aging test

79.10.1 The transmitter/receiver combination shall complete 500 alarm transmissions as described in 79.8.1 and 79.8.2, without a signal being missed, after the transmitter has been exposed for 30 days to an ambient temperature of 158 ±3°F (70 ±2°C), followed by a stabilization period of 24 hours in an ambient temperature of 73 ±3°F (23 ±2°C).

79.10.1 effective December 31, 2008

79.10.2 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.

79.10.2 effective December 31, 2008

80 Long-Range Radio Frequency (RF) Device Tests

80.1 General

80.1.1 These requirements cover the operation and performance of products and systems that utilize long-range radio frequency (RF) transmission paths, both one- and two-way, between a transmitter unit and a receiver.

80.1.1 effective December 31, 2008

80.1.2 The transmitter/receiver combination shall comply with the requirements in 80.3.5 while subjected to the conditions described in the following:

a) The adjacent channel rejection requirements in 80.5.1 – 80.5.3;

b) The intermodulation rejection requirements in 80.6.1 – 80.6.4;

c) The spurious response rejection requirements in 80.7.1 – 80.7.4;

d) The Variable Voltage Operation Test, Section 59; and

e) The Variable Ambient Temperature and Humidity Tests, Section 65.

80.1.2 effective December 31, 2008

80.1.3 The transmitter/receiver combination shall also comply with the requirements for error (falsing) rate and clash described in 80.4.1 – 80.4.6 and 80.8.1 – 80.8.4.

80.1.3 effective December 31, 2008

80.2 Reference signal level

80.2.1 For the purpose of these requirements, the minimum signal strength required for normal operating performance is designated as the reference signal level. The ambient radio-frequency noise level that would affect normal operating performance is to be designated as the maximum ambient noise level.

Exception: Alternately, the combination of the signal and noise level is to be quantified as a minimum signal-to-noise ratio.

80.2.1 effective December 31, 2008

80.2.2 These values shall be specified by the manufacturer, and a product-specific test procedure shall be provided by the manufacturer for determining, in the field, whether the actual signal strength received is above the minimum acceptable level and the actual ambient noise level is below the maximum acceptable level, or the combination of the signal and noise levels is above the minimum signal to noise ratio.

80.2.2 effective December 31, 2008

80.2.3 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 80.2.2) 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.

80.2.3 effective December 31, 2008

80.3 Throughput rate test

80.3.1 For the purpose of this requirement, the throughput rate is a measure of the ability of a receiver to accurately interpret and execute upon receipt of a correct signal, in order to achieve a high degree of assurance that alarm or emergency signals are not lost.

80.3.1 effective December 31, 2008

80.3.2 A second RF generator shall be used to produce ambient noise that is to be added to the wanted signal using a suitable combining network. A white-noise generator modulating the RF generator shall produce the noise. The frequency shall be varied across the receiver's specified width of the channel and the signal strength shall be attenuated such that the level measured at the receiver (using the method described in 80.2.2) equals the maximum ambient noise level.

80.3.2 effective December 31, 2008

80.3.3 A method of counting (which does not interfere with the normal transmitter output) shall be implemented to record the number of transmissions and correctly received messages.

80.3.3 effective December 31, 2008

80.3.4 The transmitter/receiver combination shall complete 100,000 alarm transmissions without a signal being missed, or 1,000,000 alarm transmissions with no more than one signal being missed.

80.3.4 effective December 31, 2008

80.3.5 While subjected to the conditions specified in 80.1.3, the transmitter/receiver combination shall complete 500 alarm transmissions without a signal being missed. The RF generator specified in 80.3.2 shall only be utilized for conditions in 80.1.3 (d) and (e).

80.3.5 effective December 31, 2008

80.4 Error (falsing) rate test

80.4.1 For the purpose of this requirement, 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 signals are not accepted by the receiver as valid status indications from the various transmitters in the system.

80.4.1 effective December 31, 2008

80.4.2 A second RF generator shall be used to produce ambient noise that is to be added to the wanted signal using a suitable combining network. A white-noise generator modulating the RF generator shall produce the noise. The frequency shall be varied across the receiver's specified bandwidth and the signal strength shall be attenuated such that the level measured at the receiver (using the method described in 80.2.2) equals the maximum ambient noise level.

80.4.2 effective December 31, 2008

80.4.3 A method of counting (which does not interfere with the normal transmitter output) shall be implemented to record the number of transmissions and correctly received messages.

80.4.3 effective December 31, 2008

80.4.4 The transmitter is to be conditioned for continuous transmissions of:

a) 1,000,000 messages with one incorrect element, then

b) 1,000,000 messages with two incorrect elements, and finally

c) 100,000 messages with three elements incorrect.

80.4.4 effective December 31, 2008

80.4.5 The transmitter/receiver combination shall comply with Table 80.1.

80.4.5 effective December 31, 2008

Table 80.1
Error (falsing) rate test

Table 80.1 effective December 31, 2008

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

80.4.6 When zero incorrect messages having one or two incorrect elements are accepted as valid after the first 100,000 messages at any of the three test conditions (see 80.4.4), 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.

80.4.6 effective December 31, 2008

80.5 Adjacent channel rejection test

80.5.1 For the purpose of this requirement, the adjacent channel rejection is defined as the ability of the receiver to reject unwanted signals having a carrier frequency spaced one channel above and below that of the transmitter.

80.5.1 effective December 31, 2008

80.5.2 A second RF generator shall be used to produce an unwanted input signal, which is to be added to the wanted signal using a suitable combining network. The unwanted signal shall be modulated with 400 hertz at 60 percent of the maximum permissible frequency deviation. The level of the unwanted signal shall be adjusted such that the ratio of unwanted to wanted signal level is minus 70 decibels for channel spacings greater than or equal to 20 kilohertz, and minus 60 decibels for channel spacings less than 20 kilohertz.

80.5.2 effective December 31, 2008

80.5.3 The receiver/transmitter combination shall comply with the requirements in 80.3.5 while operating with the unwanted signal spaced one channel above the carrier frequency, and again with the unwanted signal spaced one channel below the carrier frequency.

80.5.3 effective December 31, 2008

80.6 Intermodulation rejection test

80.6.1 The intermodulation rejection is the ability of a receiver to prevent two unwanted input signals, with a specific frequency relation to the wanted signal frequency, from causing degradation to the reception of a desired signal.

80.6.1 effective December 31, 2008

80.6.2 The receiver/transmitter combination shall comply with the requirements in 80.3.5 while operating under the conditions described in 80.6.3 and 80.6.4.

80.6.2 effective December 31, 2008

80.6.3 Additional RF generators shall be used to produce two unwanted input signals that are to be added to the wanted signal using suitable combining networks. The first unwanted signal shall be unmodulated and shall have a frequency 50 kilohertz above that of the wanted signal. The second signal is to be modulated with 400 hertz at 60 percent rated system deviation, and shall have a frequency 100 kilohertz above that of the wanted signal. Both signals shall have the same level, which is adjusted such that the ratio of unwanted to wanted signal is minus 70 decibels.

80.6.3 effective December 31, 2008

80.6.4 The test shall be repeated as detailed above except that the first unwanted signal is to be unmodulated and shall have a frequency 50 kilohertz below that of the wanted signal. The second signal is to be modulated with 400 hertz at 60 percent rated system deviation and shall have a frequency 100 kilohertz below that of the wanted signal.

80.6.4 effective December 31, 2008

80.7 Spurious response rejection test

80.7.1 The spurious response rejection is the ability of a receiver to prevent spurious unwanted input signals from causing degradation to the reception of a desired signal.

80.7.1 effective December 31, 2008

80.7.2 The receiver/transmitter combination shall comply with the requirements in 80.3.5 while operating under the conditions described in 80.7.3 and 80.7.4.

Exception: In lieu of conducting the throughput at each of the frequencies specified in 80.7.4, the receiver is to be monitored for SINAD at each frequency. The throughput is then to be conducted with the unwanted signal adjusted to the frequency which resulted in the lowest SINAD as compared to the SINAD of the wanted signal, and to a level such that the ratio of unwanted to wanted signal is minus 70 decibels.

80.7.2 effective December 31, 2008

80.7.3 An additional RF generator shall be used to produce an unwanted input signal that is to be added to the wanted signal using a suitable combining network. The unwanted signal shall be modulated with 400 hertz at 60 percent of the maximum permissible frequency deviation.

80.7.3 effective December 31, 2008

80.7.4 The frequency of the unwanted signal is to be adjusted to each of the values indicated below. In each case, the transmitter/receiver combination shall complete 500 alarm transmissions without a signal being missed. Frequencies in the band width that is ±100 kilohertz of the receiver frequency are to be excluded.

a) Lower Image Frequency (FC – 2 IF);

b) Upper Image Frequency (FC + 2 IF);

c) FC – 1/2 IF;

d) FC + 1/2 IF;

e) FC – IF;

f) FC + IF;

g) FC – Injected frequency;

h) FC + Injected frequency;

i) FC – focs; and

j) FC + focs;

in which:

FC is the carrier frequency;

IF is the intermediate frequency; and

focs is the local oscillator frequency.

80.7.4 effective December 31, 2008

80.8 Clash

80.8.1 For the purpose of these requirements, clash is a loss of alarm signal information at the receiver as a result of multiple transmitters being concurrently activated, as described in Components – Monitoring for Integrity, Section 53, so that their transmitted signals interfere with each other.

80.8.1 effective December 31, 2008

80.8.2 The calculated clash rate for any given system is a function of the following:

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.

80.8.2 effective December 31, 2008

80.8.3 The manufacturer shall provide a derivation of the probability of successful signal transmission, based on the probability of clashes occurring. This derivation shall provide an explicit description of the operating parameters and shall describe all the assumptions and equations used in the derivation.

80.8.3 effective December 31, 2008

80.8.4 The clash rate shall be such that:

a) There is a 90 percent probability that the time between the initiation of a single alarm signal until it is recorded at the supervising station does not exceed 90 seconds;

b) There is a 99 percent probability that the time between the initiation of a single alarm signal until it is recorded at the supervising station does not exceed 180 seconds; and

c) There is a 99.999 percent probability that the time between the initiation of a single alarm signal until it is recorded at the supervising station does not exceed 450 seconds.

80.8.4 effective December 31, 2008

81 Primary Batteries Test

81.1 Life test

81.1.1 When a primary battery is used as the main source of power for a low power radio transmitter, it shall provide power to the unit under intended ambient conditions for a minimum of one year in the standby condition and then operate the product for a minimum of 5 minutes of alarm, followed by 7 days of trouble signal. If the installation instructions of the product indicate a battery replacement period exceeding one year, the tests specified in 81.2.1 – 81.4.3 shall be conducted for that specified extended time period.

Exception: Battery life of less than one year (but not less than 6 months) under the ambient conditions specified in 81.1.2 (a) – (d) is allowed when the product is marked to indicate the ambient limitations for installation of the product.

81.1.1 effective December 31, 2008

81.1.2 Six samples of the battery (or sets of batteries when more than one is used for primary power) are to be tested under each of the following ambient conditions for the time period determined in 81.1.1 while connected to the product itself or a simulated load.

a) Room Ambient: 73.4 ±5°F (23 ±3°C), 30 – 50 percent relative humidity;

b) High Temperature: 120 ±3°F (49 ±2°C);

c) Low Temperature: 32 ±3°F (0 ±2°C);

d) Humidity: 86 ±3°F (30 ±2°C), 85 ±5 percent relative humidity.

81.1.2 effective December 31, 2008

81.1.3 For the test, either product samples or automatic test loads simulating a maximum standby current drain are to be used. The alarm load is to be the product or an appropriate load simulating maximum alarm current conditions. The batteries are to be tested in the mounting clips used in the product.

81.1.3 effective December 31, 2008

81.1.4 Terminals or jacks are to be provided on each test means to facilitate measurement of battery voltage, standby and alarm currents. The measuring means is to be separated from the battery test means by a wiring harness at least 3 feet (0.9 m) long, or other equipment that has been determined to be equivalent.

81.1.4 effective December 31, 2008

81.1.5 During the course of the test, the battery voltage and current in standby is to be recorded periodically. Once a month, the alarm load shall be momentarily connected to the battery for 30 seconds and the alarm voltage recorded after 3 seconds.

81.1.5 effective December 31, 2008

81.1.6 At the end of the test period, all batteries shall have sufficient capacity to operate the alarm signal for a minimum of 5 minutes, followed by 7 days of trouble signal. When, at the conclusion of the test period and after 5 minutes of the alarm condition, the battery voltage level is too high for the product to transmit a trouble condition, the alarm test period shall continue until the trouble signal level is obtained.

81.1.6 effective December 31, 2008

81.2 Battery trouble voltage determination

81.2.1 An increase in the internal resistance, or a decrease in terminal voltage, of a primary battery used as the source of power for a low-power radio-frequency transmitter shall not impair operation for an alarm signal before a trouble signal is obtained. In addition, any combination of voltage and resistance at which a trouble signal is obtained shall be greater than the battery voltage and resistance combination measured over the time period and in the environmental conditions described in 81.1.2.

81.2.1 effective December 31, 2008

81.2.2 The trouble level of a battery-operated product shall be determined using the test circuit in Figure 81.1 and the voltage-resistance curves of Figure 81.2 for each of the following voltages:

a) Rated battery voltage;

b) Trouble-level voltage (assuming minimal or no series resistance);

c) Voltages between rated and trouble-level voltage.

81.2.2 effective December 31, 2008

Figure 81.1
Test circuit

Figure 81.1 effective December 31, 2008

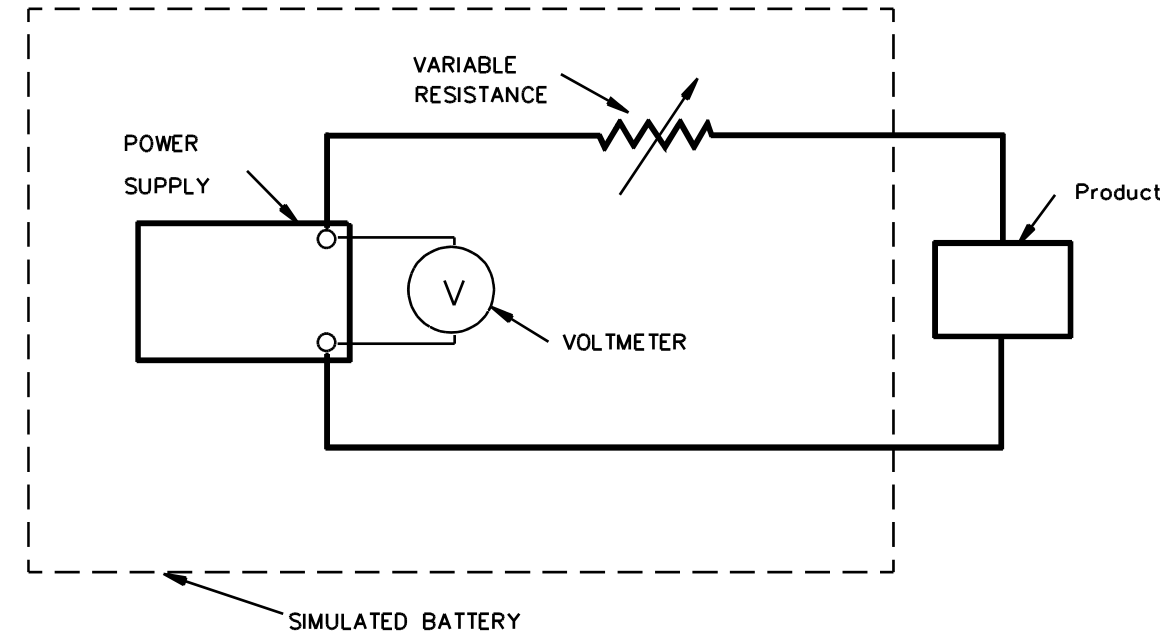
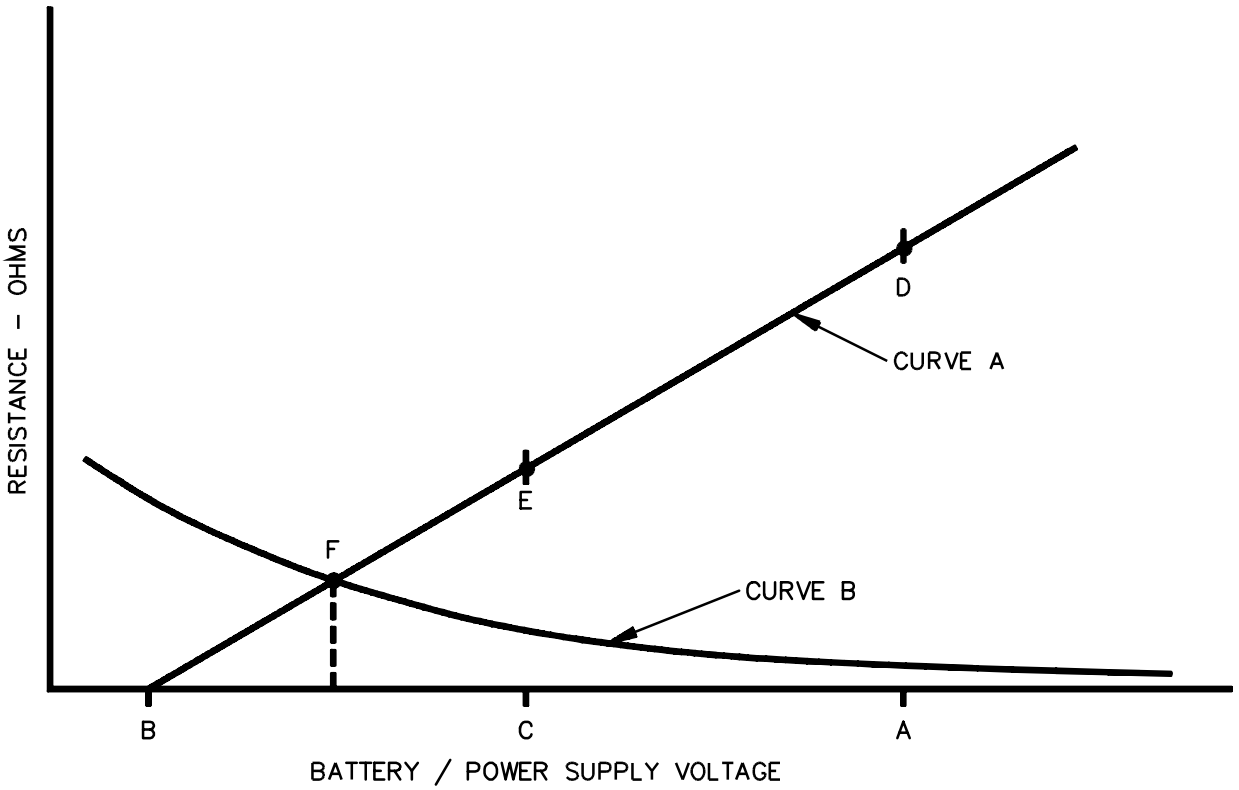


Figure 81.2
Trouble level determination

Figure 81.2 effective December 31, 2008



S2479

A – Rated battery voltage.

B – Trouble level voltage (assuming minimal resistance).

C – Voltage value between rated and trouble level.

D – Trouble level resistance at rated battery voltage.

E – Trouble level resistance at voltage value C.

F – Maximum permissible battery resistance and minimum voltage after 1 year in long-term battery test.

Curve A – Sample plot of voltage vs. resistance (product trouble level curve) at which a trouble signal in a product is obtained.

Curve B – Sample plot of battery internal resistance vs. battery open circuit voltage derived from life battery test. Shape and slope of curve, as well as point of intersection with Curve A, will vary depending on battery used.

81.2.3 To determine compliance with 81.2.1, each of three products is to be connected in series with a variable regulated direct current power supply and a variable resistor as illustrated in Figure 81.1. The trouble level is to be determined by the following steps:

a) Rated Battery Voltage – The voltage of the power supply is to be set at the rated battery voltage and the series resistor at 0 ohms. The resistor is to be increased until a trouble signal is obtained. The product is to be tested for alarm operation at each resistance level and at the trouble signal level;

b) Trouble Level Voltage – With the variable resistor set at 0 ohms, the voltage of the power supply connected to the unit is to be reduced in increments of 1/10 volt per minute to the level where the trouble signal is obtained. The product is to be tested for alarm operation at each voltage level and at the trouble signal level;

c) Voltage Values Between Rated and Trouble Level Voltages – The voltage of the power supply is to be set at pre-selected voltages between the rated battery voltage and the trouble level voltage. The series resistor is then to be increased until a trouble signal is obtained. The product is to be tested for alarm operation at each resistance and voltage level and at the trouble voltage level. A sufficient number of voltage values shall be selected to determine the shape of the trouble level curve.

81.2.3 effective December 31, 2008

81.2.4 To determine that a battery is capable of supplying alarm and trouble signal power to the product for the period specified for the product under the environmental conditions indicated in 81.1.1 – 81.1.6, Curve A of Figure 81.2 is to be plotted from the data obtained in the measurements described in 81.2.3 and compared to Curve B of the above referenced figure, which is plotted from data generated in 81.1.1 – 81.1.6. The intersection of Curves A and B shall not occur before the period specified by the manufacturer for the product. Additionally, all points of Curve B to the right of the intersection point (extended to the baseline), shall be below Curve A.

81.2.4 effective December 31, 2008

81.3 Battery replacement test

81.3.1 The battery clips intended for connecting a primary battery to a low power radio transmitter shall withstand 50 cycles of removal and replacement of the battery from the battery terminals without any reduction in contact integrity. The test shall not impair the intended operation of the product.

81.3.1 effective December 31, 2008

81.3.2 For this test, a product is to be installed as intended in service and the battery(ies) removed and replaced as recommended by the manufacturer. The product shall then be tested for intended operation.

81.3.2 effective December 31, 2008

81.4 Butt-type connection pressure test

81.4.1 When tested in accordance with 81.4.2 and 81.4.3, fixed butt-type connections of a product shall apply a minimum of 1.5 pounds (6.6 N) force to each battery contact.

81.4.1 effective December 31, 2008

81.4.2 Each battery shall be installed as intended and the position of the butt-type mounting connector(s) noted. The batteries shall be removed and the force needed to depress the butt-type connectors the same distance shall be measured.

81.4.2 effective December 31, 2008

81.4.3 When the connections are dependent upon a polymeric material, the requirement in 81.4.2 is to be completed after the mold stress-relief distortion test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

81.4.3 effective December 31, 2008

82 Strain-Relief Test

82.1 Cord-connected products

82.1.1 When tested in accordance with 82.1.2, the strain-relief means provided on the flexible cord shall be capable of withstanding for 1 minute, without displacement or damage to the wire insulation, a direct pull of 35 pounds-force (156 N) applied to the cord, with the connections within the product disconnected.

82.1.1 effective December 31, 2008

82.1.2 A 35-pound (15.9-kg) weight is to be suspended on the cord and so supported by the product that the strain-relief means is stressed from any angle that the construction of the product permits. The means of affording strain relief does not meet the requirement when, at the point of connection of the conductors, there is movement of the cord indicating stress has been transmitted to soldered connections.

82.1.2 effective December 31, 2008

82.1.3 When the strain relief is dependent upon a polymeric material, the requirement in 82.1.2 is to be completed after the mold stress-relief distortion test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, is conducted.

82.1.3 effective December 31, 2008

82.2 Field connection leads

82.2.1 Each lead used for field connections, including a battery clip lead assembly, shall withstand for 1 minute a pull of 10 pounds-force (44.5 N) without any evidence of damage or of transmittal of stress to internal soldered connections. The means of affording strain relief does not meet the requirement when, at the point of connection of the conductors, there is movement of the wire indicating stress has been transmitted to the soldered connections.

82.2.1 effective December 31, 2008

82.2.2 When the strain relief is dependent upon a polymeric material, the requirement in 82.2.1 is to be completed after the mold stress-relief distortion test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, is conducted.

82.2.2 effective December 31, 2008

83 Antenna End-Piece Secureness Test

83.1 An end-piece used to blunt the end of a sharp point shall be capable of withstanding a force of 5 pounds-force (22.3 N) applied as described in 83.2.

83.1 effective December 31, 2008

83.2 The force is to be applied by a weight that exerts a force of 5 pounds-force (22.3 N) or a steady pull of 5 pounds-force for a period of 1 minute in any direction permitted by the construction of parts at room temperature. When polymer materials are involved in the construction of the parts or the securing means, the test is to be conducted before and after the Component Temperature Test, Section 62. The results of the test do not meet the requirement when the end-piece pulls free or antenna sections are detached and expose sharp objects.

83.2 effective December 31, 2008

84 Polarity Reversal Test

84.1 A product intended to be connected to a DC supply or primary battery shall not be damaged or present a risk of fire or electric shock when connected to rated voltage when each supply connection is of the incorrect polarity. The incorrect polarity is to be applied until ultimate conditions occur. Opening of a protective fuse is not prohibited during this test.

84.1 effective December 31, 2008

84.2 One sample is to be subjected to this test. The product shall then be tested for its intended operation.

84.2 effective December 31, 2008

85 Environmental Tests for Marine Applications

85.1 All parts of the system shall comply with the environmental tests specified in the Code of Federal Regulations Title 46 – Shipping, Chapter I-Coast Guard, Dept. of Transportation, sub-sections 161.002–2 (Types of fire-protective systems), and 161.002-4 (General requirements).

85.1 effective December 31, 2008

86 Wet Location and Outdoor-Use Tests

86.1 General

86.1.1 A product intended for either indoor/wet or outdoor/wet or damp installations shall be subjected to the tests indicated in 86.2.1.1 – 86.4.7, unless indicated otherwise.

86.1.1 effective December 31, 2008

86.2 Corrosion tests

86.2.1 General

86.2.1.1 A product intended for outdoor/wet or damp locations shall operate as intended following the tests specified in 86.2.2.1 – 86.2.4.2.

86.2.1.1 effective December 31, 2008

86.2.1.2 Parts and sections of the product that are not intended to be exposed to weather shall be protected from exposure to the corrosive atmospheres representative of intended use.

86.2.1.2 effective December 31, 2008

86.2.1.3 The samples are not to be energized during these tests.

86.2.1.3 effective December 31, 2008

86.2.1.4 Two different samples of the product are to be used for each test exposure (total of six samples).

86.2.1.4 effective December 31, 2008

86.2.2 Salt spray test

86.2.2.1 The apparatus for salt spray (fog) testing is to consist of:

a) A fog chamber having inside dimensions of 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 the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117, for producing a salt fog;

e) Sample supports;

f) Provision for heating the chamber; and

g) Necessary means of control.

86.2.2.1 effective December 31, 2008

86.2.2.2 The salt solution is to consist of 5 percent by weight of common salt [sodium chloride (NaCl)] and distilled water, the pH value of the collected solution being between 6.7 – 7.2, with a specific gravity of 1.126 – 1.157 at 95°F (35°C). The temperature of the chamber is to be maintained at 95 ±3°F (35 ±2°C) throughout the test.

86.2.2.2 effective December 31, 2008

86.2.2.3 The test samples are to be suspended vertically in the test chamber for 240 hours (10 days).

86.2.2.3 effective December 31, 2008

86.2.3 Hydrogen sulfide (H_2S) test

86.2.3.1 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). The chamber is to be maintained at room temperature during the test. A small amount of water is to be maintained at the bottom of the chamber.

86.2.3.1 effective December 31, 2008

86.2.3.2 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 each reintroduction of the gas, the chamber is to be purged of the residual gas-air mixture from the exposure of the previous working day.

86.2.3.2 effective December 31, 2008

86.2.4 Sulfur-dioxide/carbon-dioxide (SO_2-CO_2) test

86.2.4.1 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). The chamber is to be maintained at room temperature during the test. A small amount of water is to be maintained at the bottom of the chamber.

86.2.4.1 effective December 31, 2008

86.2.4.2 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 each reintroduction of the gas, the chamber is to be purged of the residual gas-air mixture from the exposure of the previous working day.

86.2.4.2 effective December 31, 2008

86.3 Dust test

86.3.1 The intended operation of a product intended for outdoors use shall not be impaired by an accumulation of dust.

86.3.1 effective December 31, 2008

86.3.2 A sample in its intended mounting position is to be placed de-energized in an airtight chamber having an internal volume of at least 3 cubic feet (0.02 m^2).

86.3.2 effective December 31, 2008

86.3.3 Approximately 2 ounces (0.06 kg) of cement dust, maintained in an ambient room temperature of approximately 73.4 ±3°F (23 ±2°C) at 20 – 50 percent relative humidity and capable of passing through a 200-mesh screen (see the Standard Specification for Wire Cloth and Sieves for Testing Purposes, ASTM E11), is to be circulated for 15 minutes by means of compressed air or a blower so as to completely envelop the sample in the chamber. The airflow is to be maintained at an air velocity of approximately 50 feet per minute (0.25 m/s).

86.3.3 effective December 31, 2008

86.3.4 Following the exposure to dust, the product is to be removed, mounted in its intended position, energized from a source of supply in accordance with Details, Section 30, and examined for its intended operation.

86.3.4 effective December 31, 2008

86.4 Water spray test

86.4.1 The section of equipment intended to be exposed to an indoor or outdoor wet location shall withstand a rain exposure for 1 hour without producing a risk of electric shock or affecting the intended operation. The test shall not result in wetting of live parts.

86.4.1 effective December 31, 2008

86.4.2 The product is to be de-energized and tested under the conditions most likely to cause the entrance of water into the enclosure. Each exposure is to be for 1 hour and, when more than one exposure is required, drying of the unit prior to the second or subsequent exposure is not required.

86.4.2 effective December 31, 2008

86.4.3 Field-wiring connections are to be made in accordance with the wiring method specified for the product. Openings intended to terminate in conduit are to be sealed. Openings intended for the entry of a conductor(s) for a low-voltage circuit are not to be sealed unless seals are provided as a part of the product.

86.4.3 effective December 31, 2008

86.4.4 Products employing polymeric material(s) as all or part of the enclosure shall be subjected to the mold stress-relief distortion test as described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, prior to conducting this test.

86.4.4 effective December 31, 2008

86.4.5 Following each one-hour exposure, the product is to be examined to determine that no electrical parts are wetted and that there is no accumulation of water within the enclosure.

86.4.5 effective December 31, 2008

86.4.6 After each exposure, the complete product shall comply with the requirements of the Dielectric Voltage-Withstand Test, Section 74. In addition, the product shall operate as intended.

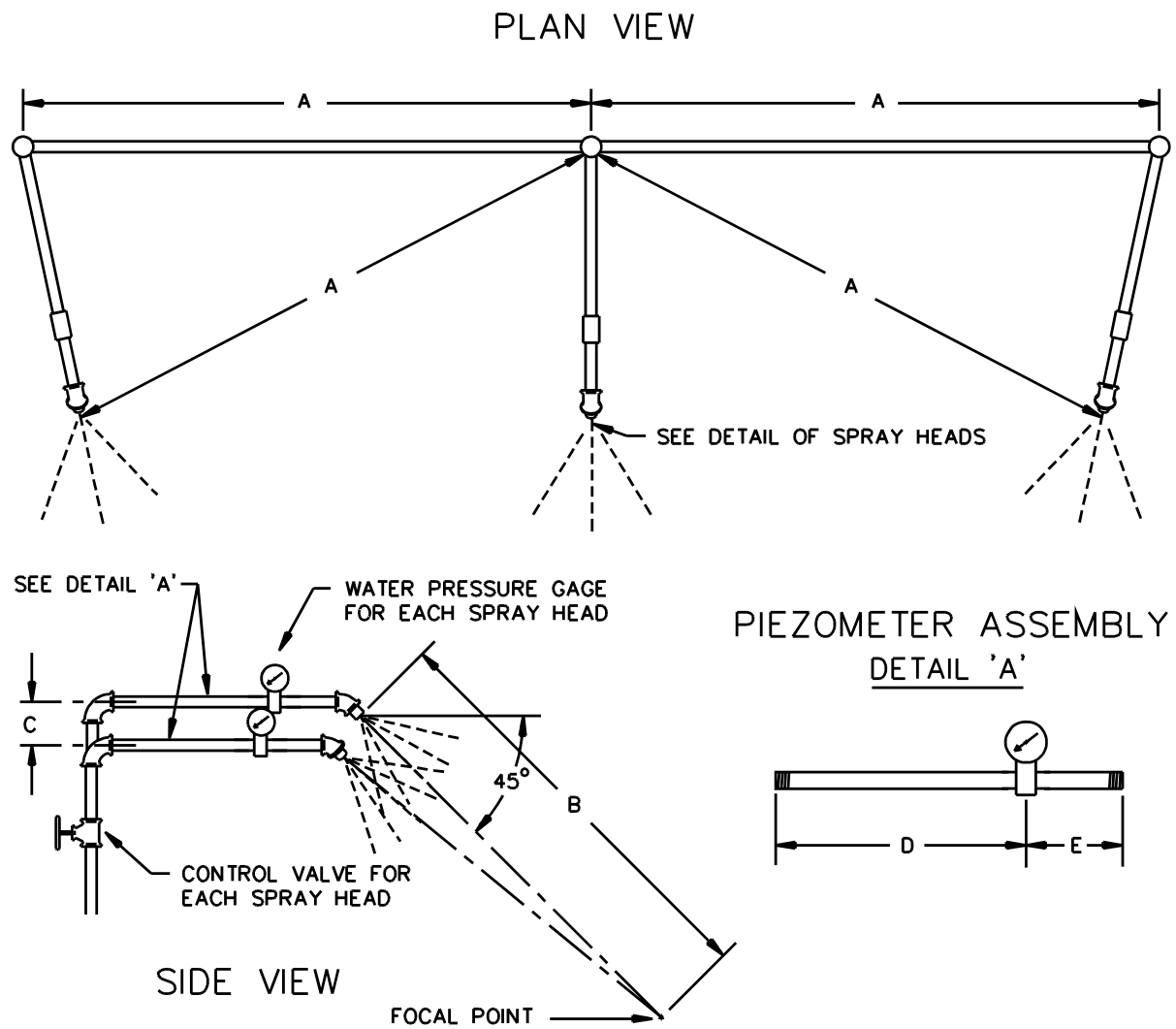
86.4.6 effective December 31, 2008

86.4.7 The rain test apparatus is to consist of three spray heads mounted in a water supply rack as shown in Figure 86.1. Spray heads are to be constructed in accordance with Figure 86.2. 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 brought into the focal area of the three spray heads in such position and under such conditions that the greatest quantity of water will enter the product. 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.

86.4.7 effective December 31, 2008

Figure 86.1
Spray head piping

Figure 86.1 effective December 31, 2008

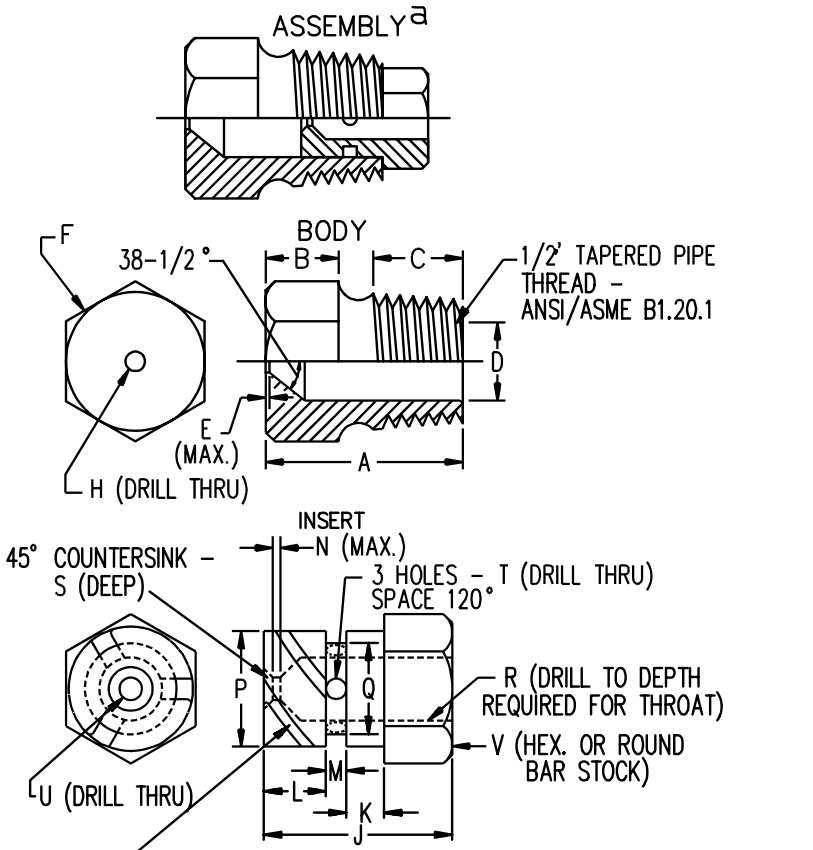


Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101E

Figure 86.2
Spray head

Figure 86.2 effective December 31, 2008



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

86.5 Gasket testing

86.5.1 General

86.5.1.1 A gasket shall be of a material able to withstand the temperature and use to which it will be subjected. The gasket material shall be resistant to aging. A gasket that will be disturbed during routine servicing, such as during battery replacement, shall be formed of resilient material such as neoprene or silicone rubber.

86.5.1.1 effective December 31, 2008

86.5.1.2 A gasket of neoprene, rubber, neoprene composition, or rubber composition used in a product intended for wet locations shall be subjected to the test in 86.5.2.1 and, when intended for outdoor use, the test in 86.5.3.1 and 86.5.3.2.

86.5.1.2 effective December 31, 2008

86.5.1.3 A gasket material other than those specified in 86.5.1.2 meets the intent of the requirement when determined to have equivalent characteristics, including resistance to aging. Such material is determined resistant to aging when there is no visible evidence of deterioration (such as cracking, after flexing, softening, or hardening) after these characteristics are investigated.

86.5.1.3 effective December 31, 2008

86.5.2 Gasket accelerated aging test

86.5.2.1 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 86.1. Results are identified as satisfying the requirements in 86.5.1.1 – 86.5.1.3 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.

86.5.2.1 effective December 31, 2008

Table 86.1
Accelerated aging conditions

Table 86.1 effective December 31, 2008

Measured temperature rise[a]				Test program[b]
More than,		Not more than,		
°F	(°C)	°F	(°C)	
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)

Table 86.1 Continued on Next Page

Table 86.1 Continued

Measured temperature rise[a]				Test program[b]
More than,		Not more than,		
°F	(°C)	°F	(°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).

86.5.3 Gasket low temperature test – outdoor use

86.5.3.1 The low temperature test is to be conducted on solid elastomer material, and both open and closed flexible cellular material utilized in products intended for outdoor use.

86.5.3.1 effective December 31, 2008

86.5.3.2 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-shaped 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.

86.5.3.2 effective December 31, 2008

86.6 Polymeric materials tests

86.6.1 A polymeric material used for (or as part of) the enclosure of a product intended for outdoor wet locations shall meet the requirements of the following tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C:

a) The Ultraviolet Light Exposure Test;

b) The Water Exposure and Immersion Test; and

c) The Resistance to Impact Test, which is to be conducted as specified in UL 746C [at a low temperature of minus 40 ±3°F (minus 40 ±2°C)].

Exception: With regard to (a) and (c), 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.

86.6.1 effective December 31, 2008

MANUFACTURING AND PRODUCTION-LINE TESTS

87 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 a breakdown or leakage of greater than 0.5 mA, 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. The test potential is to be applied 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 unit rated at 150 volts AC rms or less – either 1000 volts (1414 volts, when a DC potential is used) applied for 60 seconds or 1200 volts (1697 volts, when a DC potential is used) applied for 1 second.

b) For a unit 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, when a DC potential is used) applied for 60 seconds or 1200 volts plus 2.4 times the rated AC rms voltage (1697 volts plus 3.394 times the rated AC rms voltage, when a DC potential is used) applied for 1 second.

87.2 A printed-wiring assembly or other electronic circuit component that will be damaged by or will short circuit because of the application of the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. Where applicable, a representative subassembly is to be tested instead of an entire unit. Also where applicable, rectifier diodes in the power supply are to be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

87.3 When the unit employs both high-voltage and low-voltage circuits, the test may be conducted with the low voltage circuits connected to the cabinet, chassis, or other dead-metal parts so that the potential that is 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 revised July 14, 2005

87.4 A transformer of 500 VA or larger capacity, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with 87.1. The requirement of a 500 VA or larger transformer may be waived if the high-potential testing equipment used maintains the specified high potential voltage at the product for the duration of the test.

87.5 The test equipment used for the test in 87.1 is to include a visible indication of application of the test potential and an audible or visible indication of breakdown. In the event of breakdown, manual reset of an external switch is to be required, or an automatic reject of the unit under test is to result.

87.6 When 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.

No Text on This Page

88 Grounding-Continuity Test

88.1 Each high-voltage, cord-connected product shall be tested as a routine production-line test to verify electrical continuity between the device and the grounding blade of the attachment plug.

88.2 For this test, the manufacturer is to employ an acceptable resistance-indicating instrument with leads and terminals by which the grounding circuit continuity is to be determined.

MARKINGS AND INSTRUCTIONS

89 Markings

89.1 General

89.1.1 A product shall be plainly and permanently marked where it will be visible after installation with the following information:

a) Name or trademark (registered) of manufacturer.

b) Model number or other designation method determined to be equivalent.

c) Electrical ratings, in volts, amperes, or watts, and frequency for a cord-connected product.

d) Use of the product. For a control unit, this shall consist of the word commercial followed by protected-premises control unit or supervising-station control unit. For products other than a control unit, this shall consist of a specific use description such as annunciator, DACT interface, monitor module, end-of-line device, or other appropriate wording. In addition, separately shipped parts or components of a complete product shall be identified as a subassembly.

e) For a control unit, the type of fire alarm system supported by the product, such as local, local with shunt-type connection to master box, auxiliary, remote station (protected premises unit), remote station (receiving unit), proprietary (protected-premises unit), proprietary (receiving unit), central station (protected-premises unit), central station (receiving unit) releasing, marine, emergency communication, relocation, or smoke control.

f) Reference to the applicable National Fire Protection Association Installation Standard for each type of control unit, such as NFPA 12, 12A, 13, 15, 16, 17, 17A, 92A, 92B, 2001, or 72.

g) For a control unit, the type of fire alarm signals intended to be processed by the product (such as manual fire alarm, automatic fire alarm, supervisory, water flow alarm).

h) Type of signaling for the control unit; coded and/or non-coded, reverse polarity, multiplex, digital alarm communicator, radio frequency (RF), etc.

i) Each light, switch, meter, and similar part shall be marked adjacent to the component to indicate the intended function.

j) Reference to an installation wiring diagram, when not attached to the unit, by drawing number and issue date and/or revision level.

k) The identification of primary batteries for low-power radio transmitters by part number or manufacturer model number, located adjacent to the component.

l) For a primary battery-operated, low-powered radio transmitter, the word ″WARNING″ and the following or equivalent marking shall be included on the unit:

> ″Use Only Batteries Specified in Marking. Use Of A Different Battery May Have A Detrimental Effect On Product Operation.″

m) Compatibility identifier, consistent with 90.15(f), for products that provide initiating circuits intended to be used with two-wire smoke detectors.

Revised 89.1.1 effective December 31, 2008

89.1.2 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.

89.1.3 Marking on the product shall specifically identify all power-limited circuits by terminal designation.

Exception: When the product is of a modular construction and compliance with 89.1.3 cannot be achieved or would be inappropriate, marking on the product shall identify all modules and the associated circuits that are power-limited.

89.1.4 Identification of the executive software release level resident in the product as required by 54.1.4.

89.1.4 effective December 31, 2008

89.1.5 A unit intended for permanent connection to a wiring system other than a metal-enclosed system shall be marked to indicate the system(s) for which it is intended. The marking shall be located so that it will be visible when power connections are being made to the unit.

89.1.6 When a manufacturer produces product model at more than one factory, each unit shall have a distinctive marking to identify it as the product of a particular factory.

89.1.7 A product shall be marked for its intended installation environment (indoor or outdoor) and location (dry, damp, or wet).

89.1.7 effective December 31, 2008

89.1.8 Products intended for installation in ambients constantly more than 25°C (77°F) or intended for outdoor use, shall be marked to indicate the rated ambient air temperature.

89.1.9 There shall be legible and durable marking for each replaceable fuse indicating the ampere rating (and voltage rating when more than 125 volts) of the fuse to be used for replacement. The marking shall be located so that it is obvious which fuse or fuseholder is referenced.

89.1.9 effective December 31, 2008

89.1.10 The following marking shall be included on a control unit, separate module, or interface which incorporates an alarm verification feature. The marking shall consist of the word ″WARNING″ and the following or equivalent wording:

> THIS UNIT INCLUDES AN ALARM VERIFICATION FEATURE THAT WILL RESULT IN A DELAY OF THE SYSTEM ALARM SIGNAL FROM THE INDICATED CIRCUITS. THE TOTAL DELAY (CONTROL UNIT PLUS SMOKE DETECTORS) SHALL NOT EXCEED 60 SECONDS. NO OTHER SMOKE DETECTOR SHALL BE CONNECTED TO THESE CIRCUITS UNLESS APPROVED BY THE LOCAL AUTHORITY HAVING JURISDICTION.

Circuit (zone)	Control unit delay, seconds	Smoke detector	
		Model	Delay, seconds
			See note (a)

[a] Include detector data or the following or equivalent statement: ″The delay (power-up/start-up) time marked on the installation wiring diagram of the smoke detector or on the installed smoke detector(s) is to be used."

89.1.11 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 drawing 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 89.1.1 (c) – (h) and (m); 89.1.7; and 89.1.8.

89.1.11 effective December 31, 2008

89.1.12 The marking on an end-of-line device shall include the name or trademark of the manufacturer and model number. This marking is not prohibited from being on a tag secured to the device.

89.1.13 Accessories other than the end-of-line devices shall be marked with the name or trademark of the manufacturer, model number, electrical rating in volts, amperes or watts, and frequency for a cord-connected product, and reference to the installation wiring diagram when not attached to the product.

89.1.13 effective December 31, 2008

89.1.14 When, during the temperature test, the temperature on a lead intended to be field installed or on a surface of the wiring compartment which the lead might contact is more than the 140°F (60°C), the product shall be marked with the following statement or the equivalent, at or near the points where field connections will be made, and located so that it will be readily visible during installation. ″For Field Connections, Use Wires Suitable For At Least __°F (__°C).″ The temperature value to be used in the preceding statement shall be in accordance with Table 89.1.

Table 89.1
Temperature for marking

Temperature attained in terminal box or compartment,		Temperature in marking,	
°F	(°C)	°F	(°C)
142 – 167	61 – 75	167	75
168 – 194	76 – 90	194	90

89.1.15 In accordance with the Exception to 70.1, cord-connected products provided with an electromagnetic radiation suppression filter and having a leakage current in excess of 0.5 or 0.75 milliamperes (whichever applies) but less than 2.5 milliamperes, shall be marked with the word ″WARNING″ and the following or equivalent statement: ″To reduce the risk of electric shock, this product is provided with a grounding type power supply cord. Connect product to a grounded receptacle.″

89.1.16 When the construction of a unit is such that replacing lamps or fuses or resetting circuit breakers may expose persons to the risk or unintentional contact with normally enclosed high-voltage parts, the unit shall be marked to indicate plainly that such servicing is to be performed only while the unit is electrically disconnected from the branch-circuit supply. The marking shall be adjacent to every door or cover that requires opening before exposing the high-voltage parts.

89.1.17 With reference to the requirement in 6.4.3, a cover shall be marked with the following or equivalent: ″Circuit fuses inside only – contact service representative for replacement or repair.″ The marking shall be located on or adjacent to the cover.

89.1.18 When the construction of a unit is such that improper routing of field wiring will expose wire insulation to rough or sharp edges or subject internal components to damage, a marking shall be provided in the wiring area to indicate plainly that wiring is to be routed away from sharp projections, corners, and internal components.

89.1.19 Field-wiring terminal connections to which permanent leads are connected, such as those not intended to be removed for testing or servicing, shall be marked adjacent to the terminals.

89.1.20 A product whose surface temperatures exceed the limit specified in Table 62.2 shall be marked with the word ″CAUTION″ and the following or equivalent wording: ″Hot Surface – Avoid Contact.″ The marking shall be located on or adjacent to the surface in question.

89.1.21 A product tested using the manufacturer's instructions for voltage adjustment as indicated in the Exception to 62.6 shall be provided with a marking, as follows:

a) Adjacent to the cord or supply compartment, to warn the user that internal adjustments must be made when the product is installed or moved and

b) Showing the adjustments that must be made for various voltages.

The marking shall either be on the outside or inside of the overall enclosure of the product where visible at the points of adjustment.

89.1.22 When push-in terminals are used, the following shall be marked adjacent to the terminals: ″Do Not Use Aluminum Conductors.″

89.1.23 A product requiring a stabilizing means as specified in 29.8 shall be marked with the following or a statement determined to be equivalent: ″CAUTION – To reduce risk of possible injury due to instability, actuate stabilizer before the drawer, gate, or similar part is extended.″ The marking shall be located where it is visible to service personnel.

89.1.24 A cautionary marking shall comply with all of the following requirements:

a) The marking shall be permanently attached.

b) The marking shall not be attached to parts removable by hand.

c) The marking shall not be attached to parts likely to be replaced during maintenance or servicing.

Exception: The requirement in (c) is not applicable when the marking is integral with the replacement part.

d) The marking shall have lettering that complies with the following requirements:

1) The cautionary signal word (such as ″DANGER″, ″WARNING″, or ″CAUTION″) shall be in letters not less than 7/64 inch (2.8 mm) high.

No Text on This Page

2) The other words shall be in letters not less than 3/32 inch (2.4 mm) high and contrasting in color to the background.

3) When molded or stamped in a material not having a contrasting background color, the letters shall have a height of not less than 7/64 inch (2.8 mm) and a raised (or lowered) depth of not less than 0.020 inch (0.51 mm).

89.1.25 The removal or opening of an enclosure cover or the removal of not more than one mounting screw, or an equivalent arrangement to view the marking, is determined as complying with the requirement regarding visibility after installation.

89.2 Permanence of marking

89.2.1 Markings that are affixed to the outside of a unit, or are cautionary and located inside a unit, shall be sufficiently durable as to resist the deleterious effects of handling, cleaning agents, and similar action, anticipated in the intended use.

89.2.2 A marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, indelibly stamped lettering on a pressure-sensitive label secured by adhesive that, upon investigation, is determined to be acceptable for the application. Ordinary usage, handling, storage, and similar usage of a product are to be considered in the determination of the permanence of a marking.

89.2.3 Unless it has been investigated and determined to be acceptable for the application, a pressure-sensitive label or a label that is secured by cement or adhesive and that is required to be permanent shall comply with the applicable requirements in the Standard for Marking and Labeling Systems, UL 969.

90 Installation Wiring Diagram/Instructions

90.1 An installation wiring diagram shall be provided with each product (other than an end-of-line device) illustrating the field-connections to be made. The drawing shall be attached to the unit or, when separate, shall be referenced in the marking attached to the unit by the name or trademark of the manufacturer, drawing number, and issue date and/or revision level. When separate, a copy shall be supplied with each individual product or with each single shipment when multiples of the same product are shipped directly to an end customer in a single shipment.

90.2 The drawing shall show the installation terminals or leads to which field connections are to be made as they would appear when viewed during an installation. The terminal numbers on the unit shall agree with the numbers on the drawing.

90.3 The information specified in 90.4 – 90.11 shall be included in the installation wiring diagram.

90.4 The following information shall be marked on the installation wiring diagram/instructions for the applicable circuits to which field connections are made. In addition, each circuit shall be marked to indicate that the circuit is ″Supervised″ or is ″Not Supervised.″

a) MAIN SUPPLY CIRCUIT – Volts, frequency, and maximum current input or specific power supply with which it is intended to be used. A terminal for the connection of a grounded conductor shall be properly identified.

b) RECHARGEABLE BATTERY CIRCUIT – Voltage, maximum circuit current, maximum amp-hour capacity, type of suitable battery, and expected standby operating time(s).

c) INITIATING DEVICE CIRCUIT – The following information shall be indicated:

1) Reference to the type of devices to be used as well as their intended connection;

2) Initiating devices having integral trouble contacts shall be shown connected to the initiating device circuit such that transfer of the contacts do not impair alarm signaling from any other initiating device;

Exception: Initiating devices signaling a trouble condition caused by electrical disconnection of the device, or by removing the device from its plug-in base.

3) The maximum line impedance.

4) Maximum current, voltage, and frequency.

d) NOTIFICATION APPLIANCE CIRCUIT – The following information shall be included:

1) The type of signaling devices and their connection shall be indicated. When the circuit is intended for the connection of a polarized appliance, the field connections to which the appliance is to be wired shall be marked with plus or minus (+, -) symbols, or equivalent, to indicate the proper field connection.

2) Maximum current, voltage, and frequency.

3) The maximum line impedance or equivalent shall be indicated.

4) Each circuit shall be identified by the one of the rating designations shown in Table 61.1. Circuits identified as special application shall describe by manufacturer's name and model designation the specific appliance(s) and device(s), along with the maximum number, intended to be connected to the circuit.

5) Maximum RMS operating current for any single notification appliance that may be connected to the circuit, where synchronized notification appliances may not be employed.

6) Each circuit shall identify whether synchronized notification appliances are permitted to be connected. When synchronized notification appliances are to be employed, the maximum number that may be connected per circuit shall additionally be specified.

e) SUPPLEMENTARY CIRCUITS – Maximum current, voltage, and frequency.

f) SIGNALING LINE CIRCUIT – Maximum current, voltage, and frequency. The maximum line impedance or equivalent shall be indicated. The instructions shall describe by manufacturer's name and model designation of the specific appliance(s) intended to be connected to the circuit.

g) REVERSE POLARITY COMMUNICATIONS LINE CIRCUIT – Maximum current, voltage, and frequency, and the following, or equivalent wording, shall appear.

1) For a remote-station receiving unit: ″INTENDED FOR CONNECTION TO A POLARITY REVERSAL CIRCUIT OF A CONTROL UNIT AT THE PROTECTED PREMISES HAVING COMPATIBLE RATINGS.″

2) For a remote-station unit at the protected premises: ″INTENDED FOR CONNECTION TO A POLARITY REVERSAL CIRCUIT OF A REMOTE STATION RECEIVING UNIT HAVING COMPATIBLE RATINGS.″

In lieu of the above, a drawing of typical connection may be shown which provides equivalent information.

h) MUNICIPAL BOX CONNECTION – The type of connection, either series (local energy) or shunt, and the resistance value of the trip coil, the trip current and the maximum voltage and frequency. When a shunt-type connection is indicated, the following notation shall be added adjacent to the terminals: ″THE SHUNT CONNECTION IS RECOGNIZED ONLY AS A SUPPLEMENTARY SIGNALING UNIT AS PART OF A LOCAL CONTROL UNIT AND IS NOT RECOGNIZED AS AN AUXILIARY CONTROL UNIT CONNECTION PER NFPA 72.″

i) COMMUNICATIONS CIRCUITS – Maximum current and voltage. The maximum line impedance or equivalent shall be indicated.

Exception: Standard protocols identified as RS-232, RS-485, etc., do not require maximum current and voltage ratings.

j) POWER OUTPUT CIRCUITS – Each circuit shall be identified as either ″Regulated″ or ″Special Application″. Regulated circuits shall have a single voltage rating and maximum load current rating. Special application circuits shall describe by manufacturer's name and model designation the specific appliance(s) intended to be powered by the circuit.

k) LIMITED-ENERGY CIRCUITS – Connections to circuits that may be connected to limited energy cable shall be identified as ″Power-Limited Circuit″ or the equivalent. Specific field-wire routing instructions when required by 12.3.1 shall be included.

l) Where extra terminals are provided to which field connections are not intended, the marking NC or equivalent shall be employed.

m) RELEASING-DEVICE CIRCUITS – The voltage, frequency, and maximum current. The instructions shall also describe by manufacturer's name and model designation the specific releasing device(s) intended to be connected to the circuit.

n) RELAY, OPEN COLLECTOR, (and similar) OUTPUT CIRCUITS – The operation of the relay/open collector and similar outputs shall be designated as ″Common″, ″Zone″, or ″Programmable″ and described as specified in 57.8. The loading for the circuit, in current, voltages, frequency, and power factor, if applicable, shall also be provided.

90.4 effective December 31, 2008

90.5 In regard to the requirements in 90.4 (c) – (f), unfiltered half- and full-wave rectified voltages shall be identified.

90.6 Initiating-device, notification-appliance, and signaling-line circuits shall be designated by class or by both class and style, consistent with the circuit's capabilities as described in Tables 51.1 – 51.3, and 51.1.6. Communication and transmission paths shall be designated by type, consistent with the path's capabilities as described in 40.2.1 – 40.2.7 for active multiplex; 40.4.1 – 40.4.7 for two-way private-radio frequency multiplex; and 40.5.1 – 40.5.12 for one-way private-radio frequency systems.

90.6 effective December 31, 2008

90.7 Impedance values for testing at which ground faults are annunciated shall be specified.

90.7 effective December 31, 2008

90.8 Where a product must be mounted in a definite position to function properly, a description of the correct mounting position shall be indicated.

90.9 For a unit provided with field-wiring terminals as described in 12.5.1 and 12.5.2:

a) When a special tool is required for connection, its use shall be indicated by name of manufacturer and model number or other designation method that has been determined to be equivalent;

b) The range of wire sizes shall be indicated on the installation wiring; and

c) When means for testing for an open and a ground fault on the circuit to which the wiring is connected is not incorporated into the unit, the means shall be indicated.

90.10 Products utilizing radio-frequency signaling shall include at least the following:

a) The minimum signal strength and the maximum ambient noise level shall be indicated;

b) Specific test equipment or specific test method to be used to determine appropriate levels of signal strength and ambient noise level; and

c) Instructions to test the system for operation upon completion of installation.

90.10 effective December 31, 2008

90.11 In conjunction with 90.4(c), (d), and (f), when duplicate terminals are not provided to facilitate supervision of the installation wiring connections, and there is no provision to prevent looping an unbroken wire around or under a terminal, the word ″CAUTION″ and the following or equivalent text shall be included: ″FOR SYSTEM SUPERVISION – FOR TERMINALS ___ AND ___, DO NOT USE LOOPED WIRE UNDER TERMINALS. BREAK WIRE RUN TO PROVIDE SUPERVISION OF CONNECTIONS.″ The blanks are to be filled in with the applicable terminal identification.

Exception: Markings are not required for circuits that provide supervision without the need for duplicate terminals.

90.12 When the product consists completely of subassemblies that are to be shipped separately, the installation document for a minimum of one of the subassemblies that will be used in each product configuration shall list the subassemblies necessary to form a minimum control unit needed for each type(s) of control unit configuration and the optional subassemblies which are permitted.

90.13 An installation instruction containing the information required in 90.15 – 90.24 shall be made available by one or more of the following means:

a) Integral with the installation wiring diagram described in 90.1;

b) Separate printed instructions;

c) Electronic instructions within the basic product software;

d) Electronic media such as CD-ROM, floppy disc, website, etc.;

or the equivalent.

90.14 When the installation instructions are included as described in 90.13 (b), (c), and/or (d), the installation instructions shall be referenced in either the installation wiring diagram or product marking by:

a) Name of trademark of manufacturer;

b) Drawing number, <URL address>, and/or the equivalent identification; and

c) Issue date, revision level, and/or release date.

90.15 The installation wiring diagram/instructions for a product that provides initiating circuits intended to be used with two-wire smoke detectors shall include the following information:

a) Maximum rated operating voltage range of the initiating circuit.

b) Minimum (if applicable) and maximum number of detectors including detector name, model number and compatibility identifier.

c) When a product is intended to handle more than one detector in the alarm condition, the installation wiring diagram shall so indicate.

d) When a product is intended to handle detectors with optional features, the installation wiring diagram shall so indicate.

e) A stipulation that detectors of different models are not to be mixed or matched on a system, unless the system is specifically intended to be installed in that configuration. When mixing is permitted, specific limitations shall be included.

f) Compatibility identifier number consisting of any six-digit or less alphanumeric combination (such as a date code, part number, or model number) used to identify the latest revision that has not resulted in a new model number, but that impacts compatibility.

90.16 Description of the product operation. This shall include, as applicable, the following:

a) Normal standby,

b) Alarm,

c) Alarm test,

d) Alarm silence,

e) Alarm reset,

f) Trouble,

g) Trouble silence,

h) Off-normal position of switches, and

i) Functions of lights or switches.

90.17 Description of the maintenance procedures of the system. This shall include, as applicable, the following:

a) Fuse replacement;

b) Primary battery replacement (reference to a specific replacement part which must be used with the product shall be indicated; instructions to replace batteries periodically; the period specified shall not be greater than the useful life of the battery, which has been determined by test);

c) Rechargeable battery maintenance and replacement (where a rechargeable battery is used, proper maintenance and testing procedures shall be described); and

d) Maintenance recommendations.

90.18 Description of the testing procedures of the system (this shall include periodic testing recommendations).

90.19 Units employing the multiple detector operation described in 55.3.1 and 55.3.2 shall include guidelines for installing of a minimum of two detectors in each protected space and to reduce the detector installation spacing to 0.7 times the linear spacing in accordance with National Fire Alarm Code, NFPA 72.

90.20 For products utilizing an automatic analog smoke detector sensitivity test feature, the installation instructions shall specify the extent of the range of time intervals between activations of the automatic test feature.

90.21 The installation instructions for a control unit for releasing service shall describe whether the operation of the manual release will override an activated abort switch.

90.22 Products complying with 63.1.3 shall include a minimum secondary (standby) battery de-rating value of 10 percent, when specifying required standby capacity.

90.23 Where the field-programmable software of a product contains both complying as well as noncomplying features or parameters as permitted in 54.1.2, the following (or equivalent presentation) shall be included in the front of the programming manual or the beginning of the program section of the installation manual:

NOTICE TO USERS, INSTALLERS, AUTHORITIES HAVING JURISDICTION, AND OTHER INVOLVED PARTIES

This product incorporates field-programmable software. In order for the product to comply with the requirements in the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864, certain programming features or options must be limited to specific values or not used at all as indicated below.

Program feature or option	Permitted in UL 864? (Y/N)	Possible settings	Settings permitted in UL 864

90.23 effective December 31, 2008

90.24 The installation document for products intended for smoke control applications shall include an explanation of the concepts and requirements for smoke control, consistent with Recommended Practice for Smoke-Control Systems, NFPA 92A, and Recommended Practice for Smoke-Control Systems in Malls, Atriums, and Large Areas, 92B, and specifically how the manufacturer's smoke control equipment can be used to accomplish the intended smoke control functions. Typically, the following shall be included:

a) Concepts and requirements for smoke control strategy;

b) Delineation of the specific control equipment intended to be employed to form smoke control systems;

c) Wiring diagram(s) showing intended interconnection of the equipment, including guidelines for connection to general HVAC equipment, if separate, as well as to equipment for any required end-to-end verification process;

d) Examples for implementing the system in various applications, such as a warehouse and a high rise application; and

e) Programming of the system for the applicable strategies, including an automatic weekly test for dedicated type systems.

91 Operating Instructions

91.1 A control unit that is not intended to have an operator in attendance shall be provided with simple operating instructions. These instructions shall be on the cabinet front or on a separate sheet that can be framed and located adjacent to the control unit.

91.2 When separate from the control unit, the instructions shall include the model number of the control unit and be referenced in the control unit marking by number and issue number and/or date.

91.3 The instructions shall include a capsule description of pertinent conditions applicable to the particular control unit as described in 90.16 and 90.17.

91.4 In addition to the requirements in 91.1 – 91.3, a blank space shall be provided on the instruction sheet to fill in the name, address, and telephone number of the local service representative to contact in the event of trouble.

91.5 Where the instructions appear on a separate sheet, a notation shall be added on the bottom that the instructions are to be framed and placed adjacent to the control unit for ready reference.

91.6 Operating instructions are not required for a remote station, proprietary, or central station protected premises unit that has no user operating controls and where all signals are annunciated at the receiving unit.

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

Amplifiers for Fire Protective Signaling Systems – UL 1711
Attachment Plugs and Receptacles – UL 498
Capacitors and Suppressors for Radio- and Television-Type Appliances, – UL 1414
Circuit-Breaker Enclosures, Molded-Case Circuit Breakers, Molded-Case Swtiches and – UL 489
Communications-Circuit Accessories – UL 1863
Cord Sets and Power-Supply Cords – UL 817
Double Insulation Systems for Use in Electrical Equipment – UL 1097
Electric Fans – UL 507
Electromagnetic Interference Filters – UL 1283
Flexible Cord and Fixture Wire – UL 62
Fuseholders – UL 512
Information Technology Equipment – UL 60950
Insulating Materials – General, Systems of – UL 1446
Lampholders, Edison-Base – UL 496
Lithium Batteries – UL 1642
Marking and Labeling Systems – UL 969
Plastic Materials for Parts in Devices and Appliances, Tests for Flammability of – UL 94
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Power Units, Class 2 – UL 1310
Printed-Wiring Boards – UL 796
Protectors for Data Communications and Fire Alarm Circuits – UL 497B
Protectors for Paired-Conductor Communications Circuits – UL 497
Sharpness of Edges on Equipment, Tests for – UL 1439
Switches, General-Use, Snap – UL 20
Switches, Special-Use – UL 1054
Tape, Polyvinyl Chloride, Polyethylene, and Rubber-Insulating – UL 510
Terminal Blocks – UL 1059
Transformers, Class 2 and Class 3 – UL 1585
Transformers, Specialty – UL 506
Transient Voltage Surge Suppressors – UL 1449
Tubing, Extruded Insulating – UL 224
Wire Connectors and Soldering Lugs for Use with Copper Conductors – UL 486A
Wires and Cables, Thermoplastic-Insulated – UL 83
Wires and Cables, Thermoset-Insulated – UL 44

No Text on This Page

Superseded requirements for
the Standard for
Control Units and Accessories for Fire Alarm Systems

UL 864, Ninth Edition

The requirements shown are the current requirements that have been superseded by requirements in this edition. The numbers in parentheses refer to the new requirements with future effective dates that have superseded these requirements. To retain the current requirements, do not discard the following requirements until the future effective dates are reached.

1.1 These requirements cover electrical control units and accessories for fire-protective signaling systems to be employed in ordinary indoor locations in accordance with the following Standards of the National Fire Protection Association:

NFPA 12 Carbon Dioxide Extinguishing Systems

NFPA 12A Halogenated Extinguishing Agent Systems, Halon 1301

NFPA 12B Halogenated Extinguishing Agent Systems, Halon 1211

NFPA 70 National Electrical Code

NFPA 72 Installation, Maintenance, and Use of Protective Signaling Systems

7.6.1 (6.3.1) Polymeric materials used as an enclosure, or for the support of current-carrying parts shall comply with the applicable portion of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

13.2.2 (11.3.2.4) If a knot in a flexible cord serves as strain relief, the surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, which may cause abrasion of the insulation on the conductors.

14.3.4 (12.2.4) The wiring terminals of a control unit intended for mounting in an outlet box shall be so located or protected 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.

21.10 (33.3.4, 36.2.8, 45.3.2) A switch for silencing alarm-sounding appliances shall comply with the following requirements:

a) The off-normal position of the switch shall be indicated by an audible trouble signal, or by a lamp or other visual annunciator during any operating condition of the control unit.

b) If any switch of a multiple-circuit control unit is in the off-normal position, there shall be an indication of the related circuit by an identified lamp or other visual annunciator, and operation of the alarm-sounding appliances by any other circuit having its alarm-silencing switch in the normal position shall not be prevented.

c) The switch of a local, auxiliary, remote station (protected premises), proprietary (protected premises), or central station (protected premises) control unit shall be either a key-lock type or located inside of a locked enclosure.

d) The off-normal position of a switch of a remote station receiving system control unit shall be indicated by an audible trouble signal upon restoration of the circuit which has caused the alarm signal. An audible trouble signal is not required if the alarm sounding circuit is reconditioned automatically to operate for signals with the switch off-normal.

e) The operation to off-normal of an alarm silencing switch during an alarm condition shall not result in reenergization of a circuit intended for connection to releasing devices and fan motors controlling air-conditioning and ventilating equipment.

f) Silencing of the alarm sounding devices of a local control unit shall be indicated by an identified visual indicator. If silencing can be accomplished in a selective or zone manner, the visual indicator(s) shall distinguish indicating circuits which have been silenced from indicating circuits which are still energized. Silencing an alarm condition resulting from an alarm in one initiating device circuit shall cause all silenced alarm indicating circuits to reenergize (resound) due to a subsequent alarm in any other control unit initiating device circuit.

Exception: If a control unit is intended to provide signaling service to two or more physically separated buildings or zones, resounding of the indicating device circuits only on a zone basis is permitted. Specifics covering installation constraints shall be clearly detailed in the control unit installation wiring diagram.

21.13 (33.5.1, 36.2.10, 38.3.1, 45.4.1) The signal indication resulting from the operation of a control unit for sprinkler-equipment supervisory signals shall include distinctive signals for both the off-normal and the restoration-to-normal conditions of the initiating devices.

21.14 (33.5.1, 36.2.10, 38.3.1, 45.4.1) Supervisory signals of a local control unit shall be distinctive in sound from other signals used by the signaling system and this sound shall not be used for any other purpose, except that it may be used to indicate a system trouble condition. When the same sound is used for both supervisory and trouble signals, distinction between signals shall be indicated by a visible means and silencing of a trouble signal shall not prevent subsequent sounding of supervisory signals.

21.15 (33.3.4, 36.2.8, 45.3.2) The signal indication resulting from the operation of a local-system-control unit for a sprinkler-system water-flow alarm signal shall include continuous operation of an alarm bell. An alarm bell silencing switch shall not be permitted unless the alarm indication is transferred to a lamp or other visual indicator, and subsequent alarms in other zones will operate the alarm signal sounding device(s).

21.18 (50.3.2) The operation of a control unit from a standby power source under normal and emergency conditions shall produce the same alarm and supervisory signals produced when the unit is connected to its main power source.

Exception: This requirement does not apply to the trouble signal that activates when the main operating power becomes incapable of operating the system.

21.19 (50.2.3) Operating power of the system shall automatically be transferred to the standby power source within 30 seconds after total loss of main power, or degradation of main power to less than 85 percent of rated voltage. Transfer to the standby power source may occur between 85 and 90 percent of rated voltage. Restoration of control-unit operation to the main operating source shall occur within 30 minutes of the time main power voltage reaches a value not more than 90 percent of rated voltage.

Exception No. 1: A lower transfer cutout voltage is acceptable, provided that operation of the control unit is not impaired.

Exception No. 2: For units employing an uninterruptible power source, a signal shall be provided to indicate when the uninterruptible power source system switches from primary power to secondary power.

22.3 (50.2.2) The requirement of 22.1 does not apply to the following circuits:

a) Circuits for trouble-indicating devices.

b) A circuit for a bell, register, or similar indicating device included as a part of the control-unit assembly.

c) A circuit for a supplementary signal annunciator, signal-sounding appliances, motor stop, or similar appliance, provided that neither a short circuit, a break, or a ground fault in no way affects the normal operation of the control unit except for omission of the supplementary feature. If necessary to comply with the above requirement, overcurrent protective devices provided for supplementary circuit protection shall be noninterchangeable.

d) The circuit of a printer, time stamp, register, or main power supply in the supervising station of the proprietary system, remote station system, or central station system.

e) A circuit for shunt noninterfering performance of initiating devices of a control unit, provided that a fault condition of the circuit wiring results only in the loss of the noninterfering feature of operation.

f) The neutral of a three-, four-, or five-wire AC or DC light-and-power supply circuit.

g) A supplementary source of power used as an auxiliary means for maintaining normal operation of a system-control unit when the main supply source is interrupted.

h) The circuit of an alarm bell intended to be installed in the same room with a system-control unit, provided the bell-circuit conductors are to be installed in conduit or have equivalent protection against mechanical injury and tampering.

i) The leads of a trickle-charged battery.

j) The circuit connections extended to additional equipment provided that these wiring connections are intended to be made within 20 feet (6.1 m) and are enclosed within conduit. This would also apply to supervision between more than one enclosure of a control unit.

22.7 (51.1.4) A single break or a single ground fault in any electrically supervised initiating device or indicating-device circuit, or interruption and restoration of any source of electrical energy connected to a control unit, shall not cause an alarm signal.

22.18 (53.5) The operation of any manual-switching part of a control unit to other than its normal position while the control unit is in the supervisory condition shall be indicated by an audible trouble signal or by a lamp or other visual annunciator, if the off-normal position of the switch interferes with normal operation of the control unit.

22.20 (52.5) Except as indicated in 22.23 and 22.26, a trouble signal shall be distinguishable from an alarm signal and shall be indicated by the continuous operation of a sounding appliance, which may be common to several supervised circuits. A switch for silencing the sounding device may be provided only if a visible trouble indicator remains activated or is simultaneously activated when the sounding device is switched off. The audible trouble signal shall sound if the switch is in its ″silence″ position and no trouble exists. The visible indicator shall maintain its display until the silencing switch is restored to its ″non-silencing″ position.

Exception: Means for silencing the audible trouble signal at a proprietary central supervising unit may be provided only if the act of silencing following receipt of one trouble signal does not prevent its operation upon receipt of subsequent trouble signals.

24 (58) Input and Output Current and Voltage Test

24.1 General

24.1.1 The input or output current of each circuit of a control unit shall not exceed the marked rating of the control unit by more than 10 percent when the control unit is operated under the conditions of intended use and with the control unit connected to a rated voltage supply circuit.

24.1.2 The measured voltages at the output circuits, with the maximum (rated) loads applied, shall be compatible with the rating of the device or appliance intended to be connected to the circuit.

24.1.3 A low voltage circuit of a system control unit shall comply with the limits specified in 3.32(b).

24.2 Circuits operated from regulated control-unit power supplies

24.2.1 With the control-unit input voltage adjusted to 110 percent of rated value, the output voltage of each circuit shall not exceed 110 percent of rated value when no load, or a minimum load specified by the manufacturer, is connected to each output circuit. The input voltage then is to be reduced to the test value determined by Table 20.1, and rated load connected to each output circuit. When the input voltage then is reduced to 85 percent of rated test value, the output voltage measured at the terminals of the particular circuit shall not be less than 85 percent of rated voltage, with automatic transfer for brownout disconnected, if supplied.

24.2.2 Rated load, as applied to the requirements of 24.2.1, is that value of resistive load which causes the rated current to flow when the load is connected to the output and voltage is adjusted to the value determined by Table 20.1.

24.3 Circuits connected to specific application devices

24.3.1 If a control unit output circuit is intended to be connected to a specific piece of equipment referenced by model number in the installation instructions, it need not comply with the requirements of 24.2.1 and 24.2.2, provided that it complies with all other requirements of this standard while connected to the load with which it is intended to be used.

24.3.2 A control unit intended to be employed with a floating battery shall have sufficient capacity to maintain the battery charged under all conditions of intended operation, including sufficient capacity to operate the system under alarm conditions with the battery disconnected. In the normal supervisory condition, the battery charger shall be capable of maintaining the battery in the charged condition when the control-unit input is at a maximum of 85 percent of rated voltage or at some lower level of transfer voltage as determined according to 21.19. The same regulation shall be provided with the battery disconnected as required for a control unit equipped with regulated or unregulated power-supply circuitry.

Exception: A proprietary or central station protected premises control unit is not required to operate with the battery disconnected if the following provisions are made:

a) The unit is installed as part of a continually manned system.

b) Both the connection to and the condition of the standby battery or batteries is supervised in such a way that a trouble signal is transmitted to the central receiving unit when battery capacity degrades to a level where sufficient power for emergency operation is no longer available.

c) The unit maintains the standby battery or batteries in a charged condition, as determined by the test sequence described in the Charging Current Test, Section 29.

24.3.3 A charged battery is defined as a battery having the capacity to maintain the system control unit in the normal supervisory condition for a specified period of standby service, either 24 or 60 hours, and generate alarm transmission, evacuation signals lasting at least 5 minutes, or release of extinguishing agents or load, or both, as applicable.

28.16 (62.15) In a control unit having provision for multiple zones, 10 percent of the total number of zones, but in no case less than three zones, shall be energized during the alarm condition.

29.2.4 (63.2.5) At the conclusion of the discharge period, maximum rated load is to be applied for 5 minutes. Battery terminal voltage of the discharge battery then is to be measured.

31 (59) Overvoltage and Undervoltage Operation Test

31.1 The operating parts of a control unit shall be able to withstand 110 percent of its rated voltage continuously without damage during the normal supervisory condition, and the control unit shall operate successfully during the normal signaling condition at the increased voltage. It shall also operate successfully at 85 percent of its rated voltage.

31.2 For operation at the higher voltage specified in 31.1, the control unit is to be subjected to the increased voltage during the normal supervisory condition until constant temperature of its parts is reached, and then tested for the signaling conditions. For this test, zero line impedance will be employed in the initiating device circuit.

31.3 For operation at the lower voltage specified in 31.1, the control unit is to be subjected to rated voltage during the supervisory condition until constant temperature of its parts is reached and then tested immediately for the normal signaling condition at the reduced voltage. In making the reduced voltage test, the voltage is to be reduced by a means which will maintain a stable potential of the required value under the most severe conditions of normal loading. The reduced voltage value is to be computed on the basis of the rated nominal voltage when a storage battery is intended to be employed with the control unit.

31.4 If the maximum impedance of an initiating circuit extended from a control unit is required to be less than 100 ohms in order to obtain successful operation, the reduced voltage test is to be made with the maximum impedance connected to the circuit. If no impedance limitation is indicated in the marking, 100 ohms shall be employed in the initiating device circuit. For a signaling line circuit of a control unit the maximum impedance indicated on the installation wiring diagram shall be used.

31.5 A releasing-device control unit or local control unit acceptable for release of extinguishing agent is to be tested for operation at the lower voltage specified in 31.1. The maximum number of squibs or other releasing components are to be connected. Each releasing component shall operate when a release signal is received at the control unit.

32 (64) Standby Operating Power Test

32.1 Releasing-device control units and local control units acceptable for release of an extinguishing agent shall be capable of releasing the agent after 24 hours of operation of the standby source of power with which it is provided. When the primary AC power to the control unit is momentarily reconnected prior to operation for extinguishant release, the resulting internal electrical transients shall not cause false operation of the release mechanism or circuitry.

32.2 If the unit configuration employs cross-zone release or single-zone, multiple-detector actuation, the standby operating source shall be capable of supplying an additional 5-minute alarm signal immediately followed by the capability of releasing the extinguishing agent.

32.3 If a continuous load, such as that created by solenoid release valves, motor mechanisms, and the like, is specified, the standby operating source shall maintain at least 85 percent of the rated operating voltage to the releasing devices after 60 seconds energization of the release circuit. If voltage is less than 85 percent of rated level when 60 seconds have elapsed, the maximum time during which the standby operating source maintains the minimum operating voltage (85 percent of rated voltage) shall be specified.

38.1.1 (71.1.1) A control unit shall operate for its intended signaling performance after being subjected to 500 supply line transients, 500 internally induced transients, and 60 output circuit transients while energized from a source of supply in accordance with 20.2.

38.3.1 (71.3.1) The control unit is to be energized in the intended standby condition from a rated source of supply which is to be interrupted a total of 500 times. Each interruption is to be for approximately 1 second at a rate of not more than six interruptions per minute. At the conclusion of the test, the control unit is to operate for its intended signaling performance.

49.1.1 (89.1.1) A control unit shall be plainly and permanently marked where it will be visible after installation with the following information. Except as indicated otherwise, the information shall be marked directly on the control unit or on a separate installation wiring diagram referenced in the marking.

a) Name or trademark (registered) of manufacturer indicated on control unit.

b) Model number or equivalent, indicated on control unit.

c) Electrical ratings.

d) Type of control unit or types (if more than one type), such as local, local with shunt type connection to master box, auxiliary, remote station (protected premises unit), remote station (receiving unit), proprietary (protected premises unit), proprietary (receiving unit), central station (protected premises unit), central station (receiving unit) releasing, indicated on control unit.

e) Reference to the applicable National Fire Protection Association Installation Standard for each type of control unit, such as NFPA 12, 12A, 12B, or 72, shall be indicated on control unit.

f) Type or types of signaling service; manual fire alarm, automatic fire alarm, sprinkler supervisory water flow alarm, and the like may appear adjacent to initiating device circuit connections.

g) Correct mounting position if a control unit is intended to be mounted in a definite position.

h) Identification of lights, switches, meters, and the like regarding their function. Located adjacent to the component. See 11.6.1.

i) Maximum rating of fuses in each fuseholder. Located adjacent to the fuseholder.

50.3 (90.4) The following information shall be marked on the installation wiring diagram for the applicable circuits to which field connections are made. In addition, each circuit shall be marked to indicate that the circuit is ″Supervised″ or is ″Not Supervised.″

a) MAIN SUPPLY CIRCUIT – Volts, frequency, and maximum current input or specific power supply with which it is intended to be employed. A terminal for the connection of a grounded conductor shall be properly identified. Where the input current can vary appreciably with the extent of output circuit loading, which could affect the size of the supply circuit wire used, two or more or a range of current ratings may be shown if qualifying marking is provided indicating the limitations of loading.

b) TROUBLE SUPPLY CIRCUIT – Voltage, frequency, and maximum current input.

c) BATTERY CIRCUIT – Voltage, DC and the maximum current input. The model number of a dry-cell battery shall be indicated if a specific type is to be used. For a storage battery intended to be charged by the control unit, the maximum charging currents (trickle and fast charge) should be indicated as well as the capacity in ampere-hours.

d) INITIATING DEVICE CIRCUIT – Reference to the type of devices to be employed, such as thermostats, smoke, detectors, supervisory switches, and the like, shall be indicated as well as their intended connection. Smoke detectors shall be shown connected in an initiating device circuit such that a trouble signal emanating from a particular detector (for example, the beacon lamp in a photoelectric detector) shall not prevent operation for alarm signals from other initiating devices on the same circuit. If two wire smoke detectors are specified, the marking

specified in 50.5 shall also be provided. The maximum line impedance should be noted unless the control unit can operate with a 100 ohm impedance in each circuit. If an alarm bell silencing switch is employed on a local control unit, and the audible alarm signal is not transferred to another visible signal circuit, then the following or equivalent notation is required: ″NOT APPLICABLE FOR CONNECTION OF WATERFLOW ALARM DEVICES.″

e) INDICATING DEVICE CIRCUIT – The type of signaling devices and their connection shall be indicated. If the circuit is intended for the connection of a polarized appliance, the field connections to which the appliance is to be wired shall be marked with plus or minus (+, -) symbols, or equivalent, to indicate the proper field connection. If series connected appliances are to be connected to a circuit the following designation: ″USE SERIES CONNECTED SIGNALS RATED _____ AMPERE(S),″ or equivalent, shall be included. The blank space is to be filled in with the current rating of the appliance.

f) SUPPLEMENTARY SIGNALING CIRCUITS– Maximum current, voltage, and frequency. If the circuit is intended to be energized from a separate power supply, the position of the contacts and the condition of the circuit, supervisory, alarm, or trouble shall be indicated.

g) SIGNALING LINE CIRCUIT – Maximum line impedance, voltage, and frequency. The current operating range shall also be indicated if a field adjustment of current is indicated. For a polarity reversal type circuit, the following, or equivalent wording, shall appear.

1) For a remote station receiving unit: ″INTENDED FOR CONNECTION TO A POLARITY REVERSAL CIRCUIT OF A CONTROL UNIT AT THE PROTECTED PREMISES HAVING COMPATIBLE RATINGS.″

2) For a remote station unit at the protected premises: ″INTENDED FOR CONNECTION TO A POLARITY REVERSAL CIRCUIT OF A REMOTE STATION RECEIVING UNIT HAVING COMPATIBLE RATINGS.″

In lieu of the above markings an example or drawing of typical connection may be shown which provides equivalent information.

h) MUNICIPAL BOX CONNECTION – The type of connection, either series (local energy) or shunt, and the resistance value of the trip coil, as well as the trip current. If a shunt-type connection is indicated, the following notation shall be added adjacent to the terminals: ″THE SHUNT CONNECTION IS RECOGNIZED ONLY AS A SUPPLEMENTARY SIGNALING UNIT AS PART OF A LOCAL CONTROL UNIT AND IS NOT RECOGNIZED AS AN AUXILIARY CONTROL UNIT CONNECTION PER NFPA 72B.″

i) CONTROL-UNIT ACCESSORY CIRCUITS– Reference to the name of manufacturer, model number, and connection to the accessory shall be shown.

j) LIMITED ENERGY CIRCUITS – Connections to circuits which may be connected to limited energy cable shall be marked as follows or the equivalent: ″Power-Limited Circuit.″

k) If a special tool is required for making field wiring connections the name of the manufacturer and model number of the tool shall be specified.

l) Field wiring terminal connections to which permanent leads are connected, such as those not intended to be removed for testing or servicing, shall be marked adjacent to the terminals on the control unit to preclude removal.

m) If push-in terminals are used the following shall be marked adjacent to the terminals: ″Do Not Use Aluminum Conductors.″

n) Where extra terminals are provided to which field connections are not intended, the marking NC or equivalent shall be employed.

55.3 (39.2.11) If the central supervising station equipment is duplicated, either manual or automatic switchover shall be accomplished in not more than 90 seconds.

56.2.1 (36.3.1) As referred to in this standard, an abort switch is a manually-operated, self-restoring device that suspends the intended sequence leading to release of the extinguishing agent. Such a switch shall be marked ″abort.″

56.2.5 (36.3.5) A circuit into which an abort switch is connected shall be supervised unless a fault condition does not interfere with release of extinguishing agent.

56.3.3 (36.4.2) A control unit intended for releasing-device service shall provide for connection of a manual-release switch that shall override an abort function. This switch may be located either at a remote location or at the control unit. A maximum delay period of 30 seconds prior to operation may be incorporated.

57.3.1 (34.2.1.1) A fire-emergency system shall incorporate an automatic evacuation signal. It may also incorporate:

a) An automatic prealert tone signal.

b) An automatic prealert tone signal followed by a prerecorded message to relocate or evacuate.

c) An automatic prealert tone signal followed by a prerecorded message to relocate or evacuate, followed by an automatic tonal evacuation signal, with or without repetitive cycling of signals.

57.3.9 (34.2.1.1) If provided, a prerecorded emergency voice message shall be capable of being transmitted when a fire-alarm-initiating signal is received. The signal may be preceded by an alert tone to all speakers located within the paging zone from which the alarm originated and within other fire zones programmed to receive the signal. The alert tone, if used, may be prerecorded as part of the voice message that follows or may be automatically cued from a separate tone generator.

57.4.4 (34.3.4) An audible and visible signal distinctive from any other alarm or trouble signal shall indicate operation of a telephone call station at the fire communications panel.

58.2.4 (53.7) As part of the program-controlled system, an audible trouble signal shall activate within 90 seconds of any occurrence of the following malfunctions:

a) The system does not execute its program cycle.

b) A power-supply output upon which the operation of the system relies (such as a micro-processor, memory, disk supply, or the like) ceases to operate.

c) Rotation ceases, or fails to start when required, in a system that incorporates permanent memory-storage devices having rotating elements.

Exception: Supervision is not required if malfunction of the memory-storage device results only in loss of supplementary information or features and if the system is still capable of indicating the nature and location of any status change.

59.2 (79.1.2) These requirements are applicable to systems employing initiating device transmitters, repeater transceivers (optional) and receiver/control units with the transmitters operating on a random basis or using two-way interrogate/response signaling.

61.2 (51.5.10) The normal supervisory status transmission from a wireless initiating device circuit shall, by transmitting at a reduced power level of at least 3 decibels, or by equivalent means, provide additional assurance of successful alarm transmission capability.

62.2.1 (51.5.10) Removal of an initiating device transmitter from its installed location or removal of a cover exposing a transmitter primary battery shall cause immediate transmission of a tamper signal to the receiver/control unit that will, in turn, result in an audible and visual tamper signal individually identifying the affected device. The audible tamper signal of the receiver may be silenceable if provided with an automatic feature to resound the signal at intervals not exceeding 4 hours.

62.3.1 (51.5.11) Reception of any unwanted (interfering) transmission by a retransmission device (repeater), or by the receiver/control unit for a continuous period of 20 seconds or more, that would inhibit any status change signaling within the system, shall result in an audible and visual trouble signal indication at the receiver/control unit. This indication shall identify the specific trouble condition (interfering signal) as well as the device(s) affected (repeater and/or receiver/control unit).

62.4.3 (33.5.1, 36.2.10, 38.3.1, 45.4.1) Restoration of a supervisory device from an off-normal to the normal supervisory condition shall result in immediate communication to the receiver/control unit. Upon receipt of the restoration signal, the receiver/control unit shall either cancel the off-normal signal, or annunciate the status change by an audible and visual signal individually identifying the affected device.

62.4.4 (33.5.1, 36.2.10, 38.3.1, 45.4.1) The requirements of 21.14 and 22.11 shall also be met.

63 (79.2.1, 79.2.2, 79.2.3) Reference Level Determination

63.1 Method 1

63.1.1 The reference level test is not intended to determine the actual service communication range of a transmitter/receiver combination. Rather, this data is utilized as a reference level for the testing specified in Sections 64 – 71. The range determined during the ideal conditions of this test should not be considered representative of the actual range within a building structure, which will probably be significantly less.

63.1.2 A transmitter/receiver combination shall operate for its intended signaling performance when tested in a configuration at minimum signal strength, measured at the receiver, as specified in the manufacturer's installation instructions. The tests are to be conducted in an open, flat area characteristic of cleared, level terrain. Such test sites are to be:

a) Void of buildings, electrical lines, fences, trees, or the like;

b) Free from underground cables, pipes, lines, or the like, except as required to supply and operate the equipment under test; and

c) Free of snow and water accumulations.

The ambient radio noise level and other undesired signals are to be sufficiently low (see Methods Of Measurement Of Radio-Noise Emissions From Low-Voltage Electrical And Electric Equipment In The Range Of 10 kHz To 1 GHz, ANSI C63.4-1981) so as not to interfere with the measurements. Any large reflecting object, such as a metal fence or the like, is to be sufficiently far from the test site so as not to influence the test results. See Figure 63.1.

63.1.3 The equipment under test is to be positioned as intended in use on a wooden or other nonconducting table and framework that will permit the transmitter and receiver to be relatively oriented for worst-case communication. The mounting of the table on the framework is to be arranged so that the table surface can be adjusted to elevations of 5, 10, and 20 feet (1.5, 3, and 6 m). The number of elevations and relative positions may be reduced if the manufacturer's installation instructions provide specific limitations relating to orientation, as well as a method of testing as specified in 63.1.4.

63.1.4 Worst-case communication is that relative orientation between transmitter and receiver that results in the minimum field strength specified by the manufacturer, measured at the receiver by the appropriate installation aids and test equipment designated for that purpose.

63.1.5 The equipment and procedures specified in the installation instructions are to be used to establish test installation of the RF system.

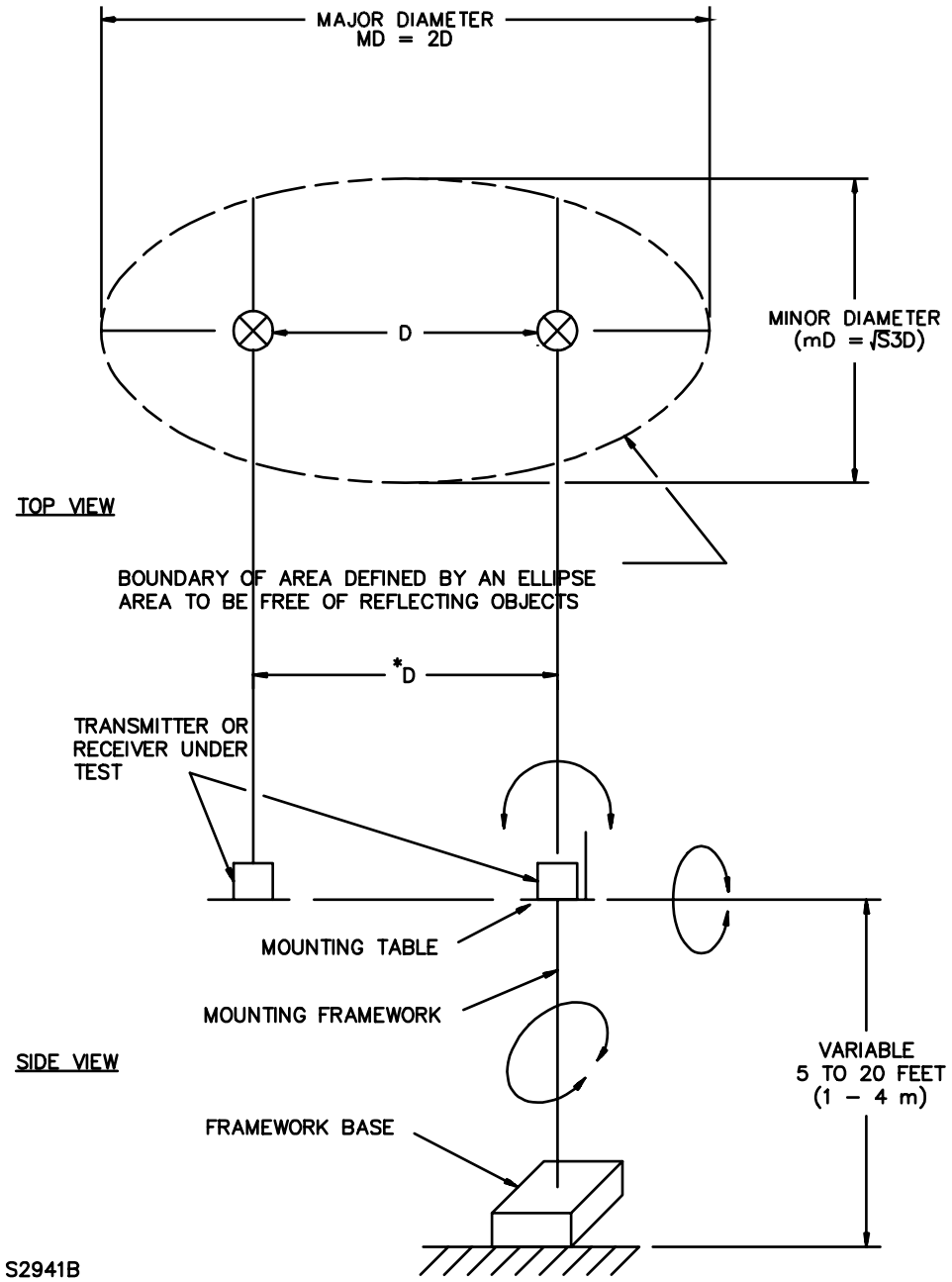
63.1.6 A sample transmitter with fresh batteries and a sample receiver are to be placed on similar tables, as specified in 63.1.3, resulting in a separation at the maximum range specified for the transmitter/receiver combination.

63.1.7 A transmitter is to be remotely activated by a nonconductive mechanism that will not increase the effective radiating or receiving size of the antenna.

63.1.8 The transmitter or receiver is to be rotated through a 90-degree angle in each of the three orthogonal axes with either the transmitter or receiver fixed in position, and the level of the received signal is to be observed for worst-case communication. The test is to be conducted at the 5-, 10-, and 20-foot (1.5-, 3-, and 6-m) elevations or as otherwise specified in 63.1.3.

63.1.9 The test is to be repeated with batteries depleted to the trouble level as specified in 62.1.1 – 62.1.4. For the purpose of this requirement, a depleted battery is defined as a battery that is at the level (terminal voltage under load) that results in a trouble signal as required in 62.1.1 – 62.1.4. For test purposes, a depleted battery may be replaced by a circuit arrangement that does not affect the RF characteristic, but does simulate the characteristics of a depleted battery as specified in 62.1.2.

Figure 63.1
Test site and equipment arrangement



NOTES:

1 For Method 1, D = manufacturer's maximum specified range, not less than 10 feet (3.05 m). Test site to comply with 63.1.2 within area defined by boundary in top view. If Method 2 is used, D = 3 m (9.84 feet).

2 Signal strength is measured at receiver.

63.2 Method 2

63.2.1 This test may be alternatively conducted in a 3-m (9.84-feet) site as described in:

a) Recommended Methods of Measurement of Radiated and Conducted Interference From Receivers for Amplitude-Modulation, Frequency Modulation, and Television Broadcast Transmissions, IEC Standard Publication 106-1974; or

b) Methods Of Measurement Of Radio-Noise Emissions From Low-Voltage Electrical And Electronic Equipment In The Range Of 1 kHz To 1 GHz, ANSI C63.4-1981.

If Method 2 is used, the test methodology described in 63.1.1 – 63.1.9 is to be followed except that the attenuation factors for receiver/transmitter specified in Figure 63.2 are to be utilized as scaling factors. 63.2.2 – 63.2.4 specify details in applying Method 2.

63.2.2 Attenuation is to be determined from the equation:

$$A = 20 \log_{10} D + 20 \log_{10} F_m - 36.6^a$$

in which:

A is the attenuation in decibels;

D is the manufacturer's specified range; and

F_m is the operating frequency in megahertz.

[a] The derived numerical value of 36.6 assumes that ground reflection is 4.7 dB average.

63.2.3 The attenuation factor for a reference signal at 3 m (9.84 feet) is to be determined from the equation:

$$A_C = A_D - A_{3M}$$

in which:

A_C is the attenuation factor;

A_D is the attenuation at manufacturer's specified range; and

A_{3M} is the attenuation at 3-meter distance.

Table 63.1 specifies the attenuation factors, A_D, for absolute attenuation at the manufacturer's specified range and the attenuation relative to the 3-meter test distance, A_C.

Figure 63.2
Signal attenuation curves

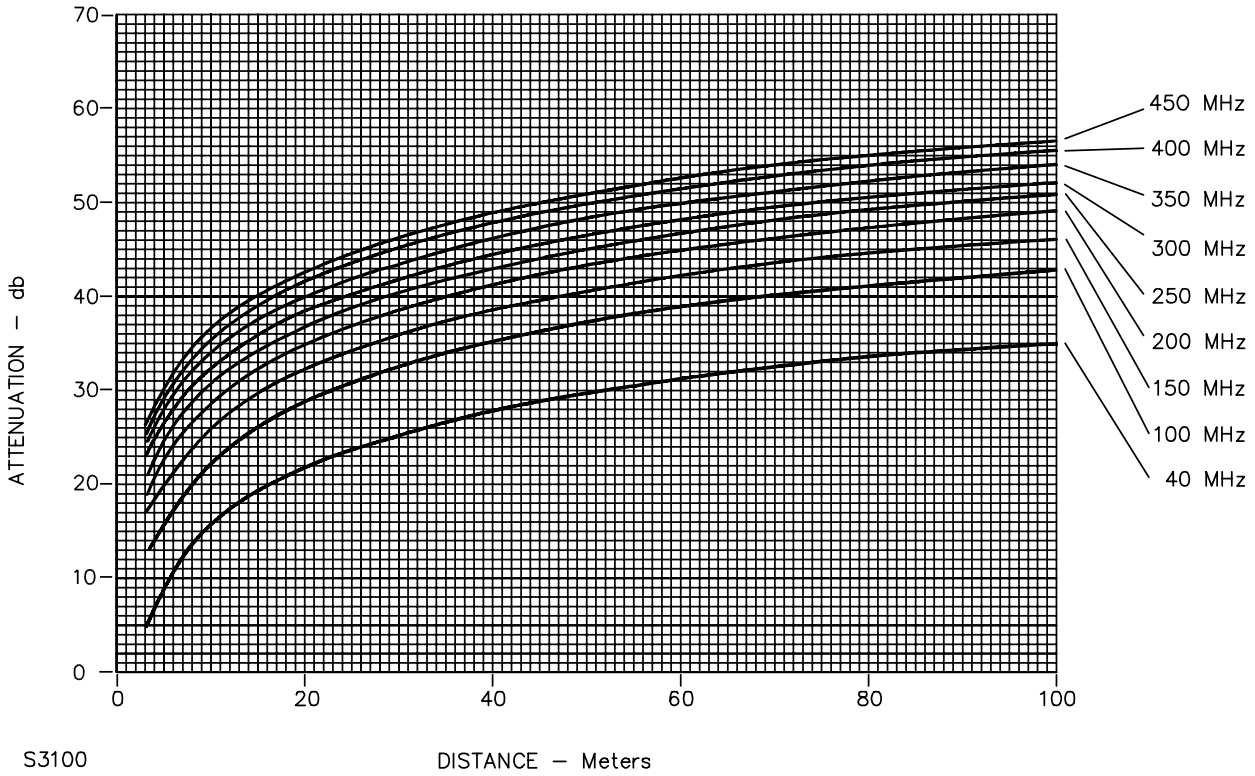


Table 63.1
Signal attenuation values

Distance, meters	A_D Frequency, 40 MHz	100 MHz	150 MHz	200 MHz	250 MHz	300 MHz	350 MHz	400 MHz	450 MHz	AC
3	4.98	12.94	16.46	18.96	20.90	22.48	23.82	24.98	26.01	–
10	15.44	23.04	26.92	29.42	31.35	32.94	34.28	35.44	36.46	10.46
15	18.96	26.94	30.44	32.94	34.88	36.46	37.80	38.96	36.99	13.98
20	21.46	29.42	32.94	35.44	37.37	48.96	40.30	41.46	42.48	16.48
25	23.40	31.35	34.88	37.37	39.31	40.90	42.24	43.40	44.42	18.42
30	24.98	32.94	36.46	38.96	40.90	42.48	43.82	44.98	46.01	20.00
35	26.32	34.28	37.80	40.30	42.24	43.82	45.16	46.32	47.35	21.34
40	27.48	35.44	38.96	41.46	43.40	44.98	46.32	47.48	48.50	22.50
45	28.50	36.46	39.97	42.48	44.42	46.01	47.35	48.50	49.53	23.52
50	29.42	37.38	40.90	43.40	45.34	46.92	48.26	49.42	50.44	24.44
55	30.25	38.20	41.73	44.22	46.17	47.75	49.09	50.24	51.27	25.27
60	31.00	38.96	42.48	44.99	46.92	48.50	49.84	51.00	52.03	26.02
65	31.70	39.66	43.18	45.68	47.62	49.20	50.54	51.70	52.72	26.72
70	32.34	40.30	43.82	46.32	48.26	49.84	51.18	52.34	53.37	27.36
75	32.94	40.90	44.42	46.92	48.86	50.44	51.78	52.94	53.96	27.96
80	33.50	41.46	44.98	47.48	49.42	50.00	52.34	53.50	54.53	28.52
85	34.03	41.99	45.51	48.00	48.95	51.53	52.87	54.03	55.05	29.05
90	34.53	42.48	46.01	48.50	50.44	52.03	53.36	54.53	55.54	29.54
95	35.00	42.95	46.48	48.97	50.91	52.50	53.84	55.00	56.02	30.01
100	35.44	43.40	46.92	49.42	51.36	52.94	54.28	55.44	56.46	30.46

63.2.4 Figure 63.2 depicts attenuation curves for signals at 40, 100, 150, 200, 250, 300, 350, 400, and 450 megahertz. The attenuation adheres to a slope of 20 decibels per decade at a given frequency.

63.2.5 The reference level is the measured signal level at 3 meters minus A_C.

64.1 (79.3.1) A receiver/transmitter combination at maximum range shall operate for its intended signaling performance in both a ″Radio Quiet″ and a ″Radio Noisy″ environment. See 64.2 and 64.3. Also see Error (Falsing) Rate, Section 68, and Throughput Rate, Section 69.

64.2 (79.3.2) For the purpose of this requirement, a ″Radio Quiet″ environment is one in which the interference signal magnitude level is at least 20 decibels peak below the desired signal as determined by 63.1.4 within the frequency band of the signal, as measured at the receiver.

64.3 (79.3.2) For the purpose of this requirement, a ″Radio Noisy″ environment is one in which the interference signal level is 10 – 20 decibels peak below the desired signal as determined by 63.1.4, as measured at the receiver. This condition is intended to test the receiver's ability to discriminate the desired signal from background noise under worst-case conditions.

64.4 (79.3.3) A ″Radio Noisy″ environment is to be created by each of the sources specified in (a), (b), and (c), connected to modulate the amplitude of an RF oscillator at 100 percent. The signal strength is to be measured at the receiver with a spectrum analyzer or other acceptable instrument to determine that the signal intensity is within the parameters defined for a ″Noisy″ environment. The interference is to emanate from a tuned 1/2 wave dipole antenna, capable of 360 degrees rotation in order to vary the polarization.

a) A white noise generator[a] modulating an RF signal generator[b] in which the frequency is varied ±5 percent about the signaling frequency.

b) Variable frequency audio oscillator[c] varied between 20 hertz to 40 kilohertz, modulating an RF signal generator in which the frequency is varied ±5 percent about the carrier frequency; image frequency, if applicable; and the intermediate frequency (IF), if applicable.

c) A square wave generator[d] varied between 20 hertz to 40 kilohertz, modulating an RF signal generator in which the frequency is varied ±5 percent about the carrier frequency; image frequency, if applicable; and intermediate frequency (IF), if applicable.

[a]General Radio Model 1382 rated 20 – 50 kilohertz or the equivalent.

[b]Hewlett Packard Model 8640B with frequency doubler option or the equivalent.

[c]Hewlett Packard Model 654A signal generator modulating the RF signal generator (or the equivalent) or may utilize the variable audio oscillator option.

[d]Square wave generator with a 600-ohm output impedance to modulate the RF signaling generator.

64.5 (79.3.4) Each of the interference signals specified in 64.4 shall not cause false alarming; however, they may cause a jamming or a loss of transmitter indication. Operation of the receiver/transmitter combination shall comply with the requirements for Error (Falsing) Rate, Section 68, and Throughput Rate, Section 69.

65.1 (79.4.1) If a product utilizes multiple frequencies, a receiver shall not respond to any signal having a signal strength equivalent to the most powerful system transmitter located at a distance of 32.8 feet (10 m) from the receiver, and having 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 megahertz wide, any signal with a similar band width, even one with identical coding, the center frequency of which is shifted by more than 10 megahertz, shall be ignored by the receiver.

65.2 (79.4.2) A receiver is to be connected to a source of rated supply and is to be positioned for intended use in a ″Radio Quiet″ environment.

65.3 (79.4.3) 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 then is to be repeatedly activated as specified in 65.1, and the receiver shall not provide an output to any signal transmitted.

65.4 (79.4.4) This test is to be conducted for frequencies above and below the receiver frequency, including at least ten additional frequencies randomly selected about the center frequency (0.5 MHz – 1.024 GHz) and outside the frequency as specified in 65.1.

65.5 (79.4.5) The test is to be monitored by a spectrum analyzer or other acceptable instrument to verify transmitter output.

65.6 (79.4.6) 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, provided that similar signal levels are generated at the receiver.

66.1 (79.5.2) The manufacturer shall provide a derivation of the rate. This derivation shall provide an explicit definition of the requirements for clash and shall describe all the assumptions and equations used in the derivation of the clash rate.

66.2 (79.5.3) The clash rate relative to normal status transmissions for each specific signal shall not exceed the following values:

a) 0.0001, for fire alarm signals,

b) 0.0005, for trouble and supervisory signals, and

c) 0.005, for other signals.

66.3 (79.5.1) For the purpose of these requirements, clash is a loss of alarm signal information 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.

66.4 (79.5.4) 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 66.2 (a) – (c), each specified factor is to be considered in the evaluation.

67.1 (79.6.1) For the purpose of this requirement, clash error is defined as the misinterpretation by the receiver of two simultaneous or overlapping valid transmitter signals which results in the receiver locking-in and annunciating a third (false) signal.

67.2 (79.6.2) A receiver shall demonstrate a zero clash error rate while subjected to the test conditions described in 67.3 – 67.5.

67.3 (79.6.3) 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 AC supply or by a DC power supply in place of a primary battery, are to be placed in close proximity to the receiver and orientated such that the manufacturer's specified signal strength is present at the receiver. The address of each transmitter shall be set such that the logical ″or″ of the two addresses is a valid address recognized by the receiver.

67.4 (79.6.4) One transmitter is to then be conditioned for continuous alarm transmission. The other transmitter shall be conditioned to transmit an alarm signal at a rate equal to twice the alarm message length for a total of 100,000 transmissions.

67.5 (79.6.5) The test described in 67.3 and 67.4 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 signal at a rate equal to twice the normal supervisory message length for a total of 100,000 transmissions.

68.1 (79.1.1) 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.

68.2 (79.7.1) For the purpose of this requirement, 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 signals are not accepted by the receiver as valid status indications from the various transmitters in the system.

68.3 (79.7.2) As a measure of compliance with 68.1, the error (falsing) rate of the receiver is to be determined by utilizing the test procedure described for reference level determination, see 63.1.3 – 63.1.9, except for the following:

a) Batteries depleted to the trouble signal level are to be installed in the transmitter. See 63.1.9 for depleted battery simulation.

b) The transmitter is to be physically oriented for ″worst-case″ signaling as determined during reference level determination. See 63.1.8.

c) A counter is to be connected to the transmitter to record the number of transmissions. The arrangement is not to interfere with the transmitter output.

d) The transmitter is to be conditioned for continuous transmissions of 1,000,000 messages with one element incorrect; then 1,000,000 messages with two elements incorrect; and finally 1,000,000 messages with three elements incorrect. See 65.6 for alternative transmitter configurations.

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 test is to be continued until at least 1,000,000 messages are completed for each of the three conditions of incorrect transmission, except that if zero incorrect messages are accepted as valid after the first 100,000 messages, the test at that number of incorrect elements per message and any higher number of incorrect elements per message need not be conducted.

g) The test shall comply with the specifications in Table 68.1.

Table 68.1(79.1)
Error (falsing) rate test

Number of incorrect elements per message	Messages completed	Maximum number of incorrect messages accepted as valid
1	100,000	1
	1,000,000	2
2	100,000	0
	1,000,000	1
3	100,000	0
	1,000,000	0

68.4 (79.7.3) The test is to be conducted in both a ″radio quiet″ and ″radio noisy″ environment as described in Interference Immunity, Section 64.

69.1 (79.8.1) For the purpose of this requirement, the throughput rate is a measure of the ability of a receiver to accurately interpret and execute upon receipt of a correct signal in order to achieve a high degree of assurance that alarm or emergency signals are not lost. The transmitter/receiver combination shall be structured so that alarm or emergency signals take precedence over all other signals. The prioritization may be achieved by extending the duration of the signal, repeating the alarm or emergency signal, 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 or panic alarm,

c) Security alarm,

d) Trouble and supervisory, and

e) Others.

69.2 (79.8.2) The throughput rate of the receiver is to be determined by utilizing the test procedure described for the error (falsing) rate, 68.3 and 68.4, except that only correct signals of each type are to be transmitted. The test results shall comply with Table 69.1. The test may be conducted for 100,000 cycles rather than 1,000,000 if the test results comply with the ″100,000 Signals completed″ row in Table 69.1.

Table 69.1(79.2)
Throughput rate test

Type of signal	Signals completed	Maximum number of missed signals in test conditions	
		Radio quiet	Radio noisy[b]
Fire	100,000[a]	4	24
	1,000,000	50	250
Trouble or supervisory	100,000[a]	19	197
	1,000,000	200	1000
Other	100,000[a]	38	195
	1,000,000	400	2000

[a] See 69.2.
[b] See 69.3.

69.3 (79.8.2) If the test results in the ″Radio Noisy″ environment comply with those corresponding missed signal specifications for the ″Radio Quiet″ environment in Table 69.1, the Radio Quiet tests are waived and the unit is considered to comply with the requirements specified in 69.2.

70.1 (79.9.1) The intended performance of a transmitter shall not be degraded nor shall the output signal frequency vary beyond the rated receiver input frequency while the transmitter and receiver are exposed and tested under the following environmental conditions:

a) 0°C (32°F) for 3 hours,

b) 49°C (120°F) for 3 hours, and

c) 85 ±5 percent relative humidity at 30 ±2°C (86 ±2°F) for 24 hours.

71.1 (79.10.1) The transmitter shall operate for its intended signaling performance as specified in 70.1 after being exposed for 30 days to an ambient temperature of 70°C (158°F), followed by a stabilization period of 24 hours in an ambient temperature of 23°C (73.4°F).

71.2 (79.10.2) 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.

73.2.7 (40.3.2.12) Failure of either of the telephone lines shall result in a trouble signal as indicated in 22.1 and the transmission of a trouble signal to the associated digital alarm communicator receiver over the operable line. The transmission shall be initiated within 4 minutes of occurrence of the fault.

73.2.9 (40.3.2.13, 40.3.2.14) A DACT shall automatically initiate and complete a test signal transmission sequence to its associated receiver at least once every 24 hours. The test signal sent when the protected premises system is in the normal supervisory condition shall be distinctively different from the test signal sent when the protected premises system is in an abnormal or unrestored condition.

Exception: A successful signal transmission sequence of any other type within the same 24 hour period is considered to comply with the intent of 73.2.9 provided that the associated receiver is capable of processing the combined signals and individually annunciating 24 hour delinquencies.

No Text on This Page

中华人民共和国国家标准

电能质量　电力系统频率允许偏差

GB/T 15945—1995

Quality of electric energy supply
Permissible deviation of frequency fof power system

国家技术监督局 **1995-12-21** 批准　　**1996-08-01** 实施

1　主题内容与适用范围

本标准规定了电力系统频率允许偏差值及其测量仪表的基本要求。

本标准适用于正常运行下标称频率为 50Hz 的电力系统。

本标准不适用于电气设备的频率允许偏差。

2　术语

2.1　频率偏差　frequency deviation

系统频率的实际值和标称值之差。

2.2　频率变动　frequency variation

频率变化过程中相邻极值频率之差。

2.3　冲击负荷　impact load

生产(或运行)过程中周期性或非周期性地从电网中取用快速变动功率的负荷。

3　频率偏差允许值

3.1　电力系统正常频率偏差允许值为±0.2Hz。当系统容量较小时，偏差值可以放宽到±0.5Hz。

3.2　用户冲击负荷引起的系统频率变动一般不得超过±0.2Hz，根据冲击负荷性质和大小以及系统的条件也可适当变动限值，但应保证近区电力网、发电机组和用户的安全、稳定运行以及正常供电。

4　测量仪表

用于频率偏差指标评定的测量，须用具有统计功能的数字式自动记录仪表，其绝对误差不大于 0.01Hz。

———————

附加说明：

本标准由全国电压电流等级和频率标准化技术委员会提出并归口。

本标准由《电能质量　电力系统频率允许偏差》国标工作组负责起草。

本标准由电力科学研究院、机械标准化研究所、国家电力调度中心、电力部信息所、纺织机械研究所、牵引电气设备研究所等单位参加起草。

本标准主要起草人林海雪、俞莘民、雷晓蒙、向海平、曹军梅、罗新潮、蔡邠。