



# UL 2034

## STANDARD FOR SAFETY

Single and Multiple Station Carbon  
Monoxide Alarms

[ULNORM.COM](https://ulnorm.com) : Click to view the full PDF of UL 2034 2024

[ULNORM.COM](https://ULNORM.COM) : Click to view the full PDF of UL 2034 2024

UL Standard for Safety for Single and Multiple Station Carbon Monoxide Alarms, UL 2034

Fifth Edition, Dated June 3, 2024

### **Summary of Topics**

***This new Fifth Edition of ANSI/UL 2034 dated June 3, 2024 includes Markings revisions.***

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated December 15, 2023 and March 22, 2024.

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 ULSE Inc. (ULSE).

ULSE 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 ULSE 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 ULSE or an authorized ULSE representative has been advised of the possibility of such damage. In no event shall ULSE's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold ULSE harmless from and against any loss, expense, liability, damage, claim, or judgment (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.

ULNORM.COM : Click to view the full PDF of UL 2034 2024

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 2034 2024

**JUNE 3, 2024**



**ANSI/UL 2034-2024**

1

**UL 2034**

**Standard for Single and Multiple Station Carbon Monoxide Alarms**

First Edition – April, 1992  
Second Edition – October, 1996  
Third Edition – February, 2008  
Fourth Edition – March, 2017

**Fifth Edition**

**June 3, 2024**

This ANSI/UL Standard for Safety consists of the Fifth Edition.

The most recent designation of ANSI/UL 2034 as an American National Standard (ANSI) occurred on June 3, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

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

Our Standards for Safety are copyrighted by ULSE Inc. Neither a printed nor electronic copy of a Standard should be altered in any way. All of our Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of ULSE Inc.

**COPYRIGHT © 2024 ULSE INC.**

No Text on This Page

[ULNORM.COM](https://ULNORM.COM) : Click to view the full PDF of UL 2034 2024

## CONTENTS

### INTRODUCTION

1	Scope .....	9
2	Components .....	9
3	Units of Measurement .....	10
4	Undated References .....	10
5	Glossary .....	10
6	Alarm Reliability Prediction .....	12
7	Battery Removal Indicator .....	13
8	Alarm Reset/Silence Feature .....	14
9	Voltage Classification .....	15
10	Lifetime .....	15

### CONSTRUCTION

11	General .....	15
	11.1 Accessories .....	15
	11.2 Sensitivity adjustment .....	16
	11.3 Supplementary signaling feature .....	16
12	Service and Maintenance Protection .....	16
	12.1 General .....	16
	12.2 Sharp edges .....	16
13	Enclosure .....	16
	13.1 General .....	16
	13.2 Cast metal enclosures .....	18
	13.3 Sheet metal enclosures .....	18
	13.4 Nonmetallic enclosures .....	19
	13.5 Ventilating openings .....	19
	13.6 Covers .....	20
	13.7 Transparent panels .....	20
14	Corrosion Protection .....	21

### POWER SUPPLY

15	Primary Power Supply .....	21
16	Secondary Power Supply (Not Applicable for Commercial Vehicles) .....	22
17	Batteries .....	22
	17.1 General .....	22
	17.2 Battery connections .....	23
18	Supplementary Signaling Circuits .....	23

### FIELD WIRING

19	Permanent Connection .....	23
	19.1 General .....	23
	19.2 Field-wiring compartment for hazardous voltage connection .....	23
	19.3 Field-wiring terminals .....	24
	19.4 Field-wiring leads .....	24
	19.5 Grounded supply terminals and leads .....	24
20	Power Supply Cord .....	25
21	Equipment Grounding .....	26
	21.1 General .....	26

21.2	Permanently-connected units .....	26
21.3	Cord-connected units .....	26
22	Remote Power Supply Leads .....	26

## INTERNAL WIRING

23	General .....	27
24	Wireways .....	27
25	Splices .....	27
26	Barriers .....	28
27	Grounding and Bonding .....	28

## ELECTRICAL COMPONENTS

28	General .....	29
28.1	Mounting of components .....	29
28.2	Operating components .....	29
28.3	Current-carrying parts .....	30
28.4	Electrical insulating material .....	30
29	Bushings .....	30
30	Lampholders and Lamps .....	31
31	Protective Devices .....	31
32	Printed-Wiring Boards .....	31
33	Switches .....	31
34	Transformers and Coils .....	31
35	Dropping Resistors .....	32
36	Spacings .....	32

## PERFORMANCE

37	General .....	33
37.1	Test units and data .....	33
37.2	Accessories .....	34
37.3	Test voltages .....	35
37.4	Component reliability data .....	35
38	Normal Operation Test .....	36
39	Circuit Measurement Test .....	37
39.1	Current input .....	37
39.2	Battery trouble voltage determination .....	37
39.3	Battery trouble silence .....	39
40	Electrical Supervision Test .....	39
40.1	General .....	39
40.2	AC powered units .....	41
40.3	Battery powered primary or secondary units .....	41
40.4	Component failure .....	42
40.5	External wiring .....	42
41	Sensitivity Test .....	42
41.1	General .....	42
41.2	Test equipment .....	44
41.3	Test method .....	44
41.4	Uniformity of operation .....	45
42	Selectivity Test .....	45
43	Sensitivity Test Feature .....	46
44	Stability Tests .....	47
45	One Year (minimum) Sensor Stability Test for CO Sensors .....	48

45.1	General.....	48
45.2	Test gas .....	49
45.3	Sensor data collection .....	50
45.4	CO sensor sensitivity test .....	51
46	Velocity-Sensitivity Test .....	51
46.1	Test procedure .....	51
46.2	Duct test equipment .....	52
46.3	Effect of air velocity – Commercial vehicles .....	53
47	Temperature Test .....	53
48	Overload Test.....	56
48.1	Alarm.....	56
48.2	Separately energized circuits .....	56
49	Endurance Test.....	57
49.1	Alarm.....	57
49.2	Separately energized circuits .....	57
49.3	Audible signaling appliance .....	57
49.4	Test means .....	57
50	Variable Ambient Temperature Test .....	58
50.1	Operation in high and low ambient .....	58
50.2	Effect of shipping and storage .....	58
51	Humidity Test .....	58
51.1	High humidity (non-condensing).....	58
51.2	Low humidity .....	59
51.3	Sensitivity measurements.....	59
52	Leakage Current Test .....	59
53	Transient Tests.....	61
53.1	General.....	61
53.2	Supply line (ring wave surge voltage) transients .....	61
53.3	Internally induced transients .....	61
53.4	Extraneous transients .....	61
53.5	Supply line (extra-low-voltage) circuit transients .....	62
54	Surge Immunity Test (Combination Wave).....	63
55	Surge Current Test .....	63
56	Dielectric Voltage-Withstand Test .....	64
57	Abnormal Operation Test .....	64
58	Overvoltage Test.....	65
59	Undervoltage Test .....	65
60	Dust Test .....	65
61	Static Discharge Test.....	66
62	Vibration Test.....	66
63	Replacement Test, Head and Cover.....	67
64	Jarring Test.....	67
65	Corrosion Test.....	68
66	Battery Tests .....	69
67	Audibility Test.....	69
67.1	General.....	69
67.2	Sound output measurement .....	70
67.3	Alarm duration test.....	70
67.4	Supplementary remote sounding appliances.....	71
68	Tests of Thermoplastic Materials.....	71
68.1	General.....	71
68.2	Accelerated air-oven aging test.....	71
68.3	Flame test (3/4 inch) .....	71
68.4	Flame test (5 inch) .....	72
68.5	Impact test .....	73
69	Paint Loading Test.....	74

70	Battery Replacement Test .....	74
71	Polarity Reversal Test .....	74
72	Electric Shock Current Test .....	75
73	Strain Relief Test .....	80
	73.1 General.....	80
	73.2 Power-supply cord .....	80
	73.3 Field-wiring leads.....	80
	73.4 Special connector .....	80
74	Power Supply Tests .....	80
	74.1 General.....	80
	74.2 Volt-amperes capacity .....	80
	74.3 Burnout test.....	81
75	Drop Test.....	81

### **CARBON MONOXIDE ALARMS FOR USE IN RECREATIONAL VEHICLES, COMMERCIAL VEHICLES, AND UNCONDITIONED AREAS**

76	General .....	81
	76.2 Marking.....	81
77	Variable Ambient Temperature and Humidity Test .....	82
78	Corrosion (Salt Spray) Test .....	82
79	Vibration Test .....	83
80	Contamination Test (Cooking By-Products) .....	83
81	Carbon Monoxide Alarms for Use on Recreational Boats.....	85
	81.1 General.....	85
	81.2 Operation tests following conditioning .....	86
	81.3 Watertightness test .....	87
	81.4 Drip test .....	88
	81.5 Abnormal operation tests .....	88
	81.6 Salt-spray corrosion test.....	89
	81.7 Marking.....	89
	81.8 Operating and installation instructions .....	89

### **MANUFACTURING AND PRODUCTION TESTS**

82	General .....	90
83	Sensitivity Calibration Tests.....	91
84	Measurement of In-Service Reliability .....	91
	84.1 Required in-service reliability .....	91
	84.2 Sample frequency and sample size .....	91
	84.3 Test results and record keeping .....	92
85	Production Line Dielectric Voltage-Withstand Tests .....	92
86	Production Line Grounding Continuity Tests .....	93
87	Audibility Test.....	93
88	Alarm Shipment .....	93

### **MARKING**

89	General .....	93
90	Marking Permanence .....	95
	90.1 General.....	95
	90.2 Permanence and legibility of marking test.....	96

**INSTRUCTIONS**

91	General .....	96
92	Installation and Operating Instructions for Evaluation .....	99

**ANNEX A (Informative) – RELIABILITY AND FAILURE RATE DETERMINATION INFORMATION**

**GENERAL**

A1	Instructions for Determining a Reliability Prediction for Carbon Monoxide Alarms.....	100
A2	Methods of Determining Failure Rate.....	100
A3	Maximum Alarm Failure Rates .....	109

**CRITERIA FOR ACCEPTANCE OF MICROELECTRONIC DEVICES**

A4	General.....	109
A5	Quality Assurance Screening Program .....	110
A6	Determination of Failure Rate Number Supplemented by Burn-In Test .....	111
	A6.1 General .....	111
	A6.2 Determination sequence .....	111
	A6.3 Test calculations and procedures.....	114
	A6.4 Test conditions .....	114
	A6.5 Failure rate number calculation.....	114

**ANNEX B (Informative) – MANUFACTURING AND PRODUCTION TESTS**

Glossary.....	117
---------------	-----

**UL REPRESENTATIVE'S DUTIES**

<b>General</b> .....	117
<b>Instructions for Inspection of Test Equipment</b> .....	118
<b>Operation check</b> .....	118
<b>Sensitivity test</b> .....	118
<b>Instructions for Inspection of the Product</b> .....	119
<b>General instructions</b> .....	119
<b>Instructions to the UL Representative for Sample Pick-Up</b> .....	120
<b>UL representative</b> .....	120

**INSTRUCTIONS FOR FOLLOW-UP TESTS AT UL**

<b>Engineering services department</b> .....	120
<b>Carbon Monoxide Sensitivity Test</b> .....	120
<b>Method</b> .....	120
<b>Results</b> .....	121

**INSTRUCTIONS FOR TESTS AND/OR INSPECTION AT THE FACTORY**

<b>Manufacturer's Responsibilities</b> .....	121
<b>Requirements for Factory Tests</b> .....	121
<b>General</b> .....	121
<b>Production Line Dielectric Voltage Withstand Test</b> .....	122
<b>General</b> .....	122

Method .....	122
Test equipment .....	122
Basis for acceptability .....	123
Production Line Dielectric Voltage-Withstand Test Equipment .....	123
Production Line Grounding Continuity Test .....	123
General .....	123
Test equipment .....	123
Method .....	123
Basis for acceptability .....	123
Electrical Function and Calibration .....	123
General .....	123
Test equipment .....	124
Method .....	124
Basis for acceptability .....	124
Electrical function and calibration .....	124
Production Line Sensitivity Calibration Test (Quarterly) .....	124
General .....	124
Test equipment .....	125
Method .....	125
Sensitivity calibration test .....	125
Production Line Sensitivity Calibration Test (Per Shift) .....	125
General .....	125
Test equipment .....	125
Method .....	126
Basis for acceptability .....	126
Sensitivity calibration test (per shift) .....	126

#### ANNEX C (Informative) – STANDARDS FOR COMPONENTS

#### ANNEX D (Informative) – MARKING MATERIAL ADHESION

#### ANNEX E (Informative) – SAMPLE SIZE DETERMINATION FOR IN SERVICE RELIABILITY TESTING

E1	General .....	129
E2	Procedure .....	136
E3	Statistical Derivation of <a href="#">Table E1.2</a> .....	137

## INTRODUCTION

### 1 Scope

1.1 These requirements cover electrically operated single and multiple station carbon monoxide (CO) alarms intended for protection in ordinary indoor locations and unconditioned areas, per applicable governing laws, codes, and standards. This includes, but is not limited to, recreational vehicles, mobile homes, commercial vehicles, and recreational boats with enclosed accommodation spaces and cockpit areas.

1.2 Carbon monoxide alarms covered by these requirements are intended to respond to the presence of carbon monoxide from sources such as, but not limited to, exhaust from internal-combustion engines, abnormal operation of fuel-fired appliances, and fireplaces. Carbon monoxide alarms are intended to alarm at carbon monoxide levels below those that cause a loss of ability to react to the dangers of carbon monoxide exposure. See [Table 41.1](#), Part A, Alarm – carbon monoxide concentration and response time.

1.3 Carbon monoxide alarms covered by this standard are not intended to alarm when exposed to long-term, low-level carbon monoxide exposures or slightly higher short-term transient carbon monoxide exposures, possibly caused by air pollution and/or properly installed/maintained fuel-fired appliances and fireplaces. See [Table 41.1](#), Part B, False alarm resistance specifications.

1.4 These requirements, where applicable, also cover all remote accessories that may be connected to or are intended to be employed with a single or multiple station carbon monoxide alarm. See [37.2.1](#).

1.5 This standard does not cover the following:

- a) Single and multiple station smoke alarms that are covered by the Standard for Smoke Alarms, UL 217, or the Standard for Smoke Alarms, ULC-S531.
- b) Smoke alarms of the nonself-contained type that are intended for connection to a household or industrial system control unit. These are included in the Standard for Smoke Detectors for Fire Alarm Systems, UL 268/ULC 529.
- c) Mechanically operated single and multiple station fire alarm devices that are specified in the Standard for Smoke Detectors for Fire Alarm Systems, UL 539 / ULC 589, or the Standard for Heat Actuated Fire Detectors for Fire Alarm Systems, ULC-S530.
- d) Heat alarms whose requirements are covered in the Standard for Heat Detectors for Fire Protective Signaling Systems, UL 521, or the Standard for Lined Building Protection Fire Hose, ULC-530.
- e) Carbon monoxide gas detectors intended for use in hazardous locations as defined in the U.S. Coast Guard Electrical Engineering Regulations.

### 2 Components

2.1 Except as indicated in [2.2](#), a component of a product covered by this standard shall comply with the requirements for that component. See Annex [C](#) for a list of standards covering components generally used in the products covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

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

### 3 Units of Measurement

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

### 4 Undated References

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

### 5 Glossary

5.1 For the purpose of this standard the following definitions apply.

5.2 ALARM, MULTIPLE STATION – A single station alarm that is able to be interconnected with one or more other alarms for common alarm annunciation.

5.3 ALARM SIGNAL – An audible and visual signal intended to indicate a gas concentration in excess of 30 ppm carbon monoxide for thirty days or 70 ppm carbon monoxide for 1 hour. The audible portion of the alarm signal shall be 4 cycles of 100 milliseconds "on"/100 milliseconds "off," then 5 seconds "off." After the initial 4 minutes of the alarm signal, the 5 second "off" period may be changed to 60 seconds±10 percent. This signal shall be repeated until the alarm resets after dissipation of CO or the alarm signal is manually silenced. The visual indicator for alarm shall be located on the face of the unit.

5.4 ALARM, SINGLE STATION – An alarm device consisting of an assembly of electrical and mechanical components including a sensor or sensors, an audible alarm, and an optional visual alarm constructed to detect the presence of carbon monoxide gas. It is powered either from an external source by means of splice leads or a cord and plug arrangement or from an integral battery or batteries. Some devices have terminals for connection to remote audible signaling appliances or accessories. Some also contain an integral transmitter for energizing a remote audible signaling appliance.

5.5 BATTERY TROUBLE LEVEL SIGNAL – Any combination of battery voltage and series resistance that results in an audible trouble signal from a battery-operated alarm.

5.6 CARBON MONOXIDE (CO) – A colorless, odorless, toxic gas.

5.7 CARBOXYHEMOGLOBIN OR CARBONMONOXYHEMOGLOBIN (COHb) – A stable combination of carbon monoxide and hemoglobin formed in the blood when carbon monoxide is inhaled. Percent carboxyhemoglobin indicates the degree to which the oxygen-carrying capacity of the blood is impeded by the uptake of carbon monoxide by the hemoglobin.

5.8 COMMERCIAL VEHICLES – US GVWR (Gross Vehicle Weight Rating) Class 6 – 8 as defined by the United States Code (U.S.C.) Title 49 – Transportation Subtitle VI – Motor Vehicle And Driver Programs, Part B – Commercial.

5.9 COMPONENT, LIMITED LIFE – A component that provides a minimum of one year of service but is expected to periodically fail and be replaced and that is supervised for failure that affects normal operation or sensitivity. Typical examples of such components include incandescent lamps, electronic tube heaters, functional heating elements, and batteries. See also [40.4.1](#).

5.10 COMPONENT, RELIABLE – A component that is not expected to fail or be periodically replaced and is not supervised. A reliable component shall have a predicted failure rated of 2.5 or less failures per million hours.

5.11 DRIP-PROOF – A product that is constructed, or so protected, so that falling drops of liquid or solid particle striking the enclosure, from 0 – 15° downward from the vertical, do not interfere with the intended operation of the equipment.

5.12 DWELLING UNIT – That structure, area, room, or combination of rooms in which a family (or individual) lives. This is intended to cover the living area only and not common usage areas in multifamily buildings such as corridors, lobbies, and basements.

5.13 END-OF-LIFE SIGNAL – An audible signal, differing from the alarm signal, intended to indicate that the device has reached the end of its useful life and should be replaced.

5.14 LONG-TERM, LOW-LEVEL CARBON MONOXIDE EXPOSURES – Situations resulting in a carbon monoxide concentration not exceeding 30 ppm for less than 30 days.

5.15 PPM – Gas concentration in parts per million.

5.16 PRE-ALARM – An optional audible or audible-visual signal above 30 ppm of CO, unique from the trouble and alarm signal, intended to provide an early notification of the detection of carbon monoxide prior to an alarm signal. When the pre-alarm signal occurs, the carbon monoxide alarm emits the unique pre-alarm signal at the indicating carbon monoxide alarm and may also send the pre-alarm signal to a wireless communication remote accessory device. The pre-alarm signal is an optional signal that when implemented does not prohibit the normal operation of the carbon monoxide alarm. When rapid levels of carbon monoxide are detected, the alarm signal takes precedence over the pre-alarm signal.

5.17 QUALIFIED APPLIANCE TECHNICIAN – A person, firm, corporation, or company that either in person, or through a representative, is engaged in and responsible for the installation, testing, servicing, or replacement of heating, ventilation, and air-conditioning (HVAC) equipment, combustion appliances and equipment, and/or gas fireplaces or other decorative combustion equipment.

5.18 SELF-CONTAINED UNIT – An alarm containing an internal battery or batteries.

5.19 SENSITIVITY – The gas concentration versus time at or above which the alarm must initiate or remain in alarm.

5.20 SENSOR – The component or combination of components of the alarm that responds to and in turn provides a usable output signal in the presence of carbon monoxide.

5.21 SHORT-TERM CARBON MONOXIDE EXPOSURE – Situations resulting in a carbon monoxide concentration not exceeding 70 ppm for less than 60 minutes.

5.22 SPECIFIED LIFETIME – A continuous period of time specified by the manufacturer, during which the alarm meets the requirements of this standard. The manufacturer will specify the start date of the period as either the date of manufacturer of the fully assembled unit in its final enclosure, or the date the unit is placed into service.

5.23 SWITCHING DEVICE – A device designed to close and/or open one or more electrical circuits.

5.24 TROUBLE SIGNAL – A visual or audible signal, differing from the alarm signal, intended to indicate a fault or trouble condition, such as an open or shorted condition of a component in the device, an open or ground in the connecting wiring, loss of AC power, or the need for replacement of a limited life component. In a product that includes more than one limited life component, other than the battery, the trouble signal shall be identified by both an audible and visual signal. The audible portion of the trouble signal shall be a single tone pattern consisting of a short "beep" of not more than 0.5 second repeating once every 30 – 60 seconds  $\pm 10$  percent. This signal shall be repeated until the trouble condition is corrected.

5.25 UNCONDITIONED AREAS – Enclosed spaces without continuous climate controls where an individual spends time and where there is a potential for carbon monoxide buildup. (Examples of unconditioned areas that may include combustible fuel appliances and/or fireplaces include attached and detached garages, crawl spaces, attics, cottages, cabins, etc.)

5.26 WARNING SIGNAL – Except for alarm and trouble signals, no other audible and visual signals shall be used (i.e. warning signals that indicate the presence of CO less than 30 ppm).

5.27 WATERTIGHT – A product that is constructed to prevent water from entering the enclosure under any condition other than submersion.

## 6 Alarm Reliability Prediction

6.1 Alarm units shall be constructed to a maximum failure rate of 4.0 failures per million hours as calculated by a full part stress analysis prediction as described in Section 2.0 of the Military Standard 217F or 3.5 failures per million hours as calculated by a simplified parts count reliability prediction as described in Section 3.0 of the Military Standard 217B, or equivalent. A "Ground Fixed" (GF) environment is to be used for all calculations. If actual equivalent data is available from the manufacturer, it is usable in lieu of the projected data for the purpose of determining acceptable reliability.

6.2 Any component whose failure results in any of the following is not required to be included in the failure rate calculations:

- a) Energization of either an audible trouble signal or energization of a separate visual indication (orange or yellow),
- b) De-energization of a power-on light,
- c) Does not affect the normal operation, or
- d) Is evaluated by specific performance tests included in this standard. Examples include the sensor, audible signal appliance, test switch, and battery contacts.

6.3 An integral or remote accessory, such as an integral transmitter or remote sounding appliance, is not required to be included in the reliability prediction except for those components whose failure affects the normal operation of the alarm.

6.4 A custom integrated circuit (CHIP) employed in an alarm shall have a predicted failure rate of not greater than 2.5 failures per million hours. The failure rate is to be determined through an evaluation of data in a 3000-hour burn-in test, or equivalent. (See Annex A for information on evaluation methods.)

6.5 The carbon monoxide sensor, or a sensing component supervision system, of a CO alarming device shall be either be reliable as required by [6.6](#) or supervised as required by [6.7](#).

6.6 If the CO sensor is to be considered reliable, reliability data shall be developed using the Military Standardization Handbook, MIL.217-F or equivalent. The data must indicate a failure rate of not more than 2.5 failures per million hours of operation.

6.7 If the CO sensor is to be considered supervised, failure modes with a likelihood of more than 2.5 failures per million hours of operation, including, but not limited to shorts, opens, and uncompensated sensitivity drift outside of the limits of [Table 41.1](#), must result in a trouble signal as required in Section [40](#).

6.8 Documentation of the sensor failure modes shall be provided.

6.9 Documentation of the failure modes shall include a description of each failure mode and the circumstances under which it may occur.

6.10 The manufacturer shall submit a test method to render the CO sensor unresponsive to the CO concentrations given in [Table 41.1](#) if the documentation submitted for the sensor or the sensing components indicates drift in the less sensitive direction. This method shall be used when conducting the Electrical Supervision Test, Section [40](#).

## 7 Battery Removal Indicator

7.1 Removal of a battery from a battery-operated carbon monoxide alarm shall result in a readily apparent and prominent visual indication. The visual indication shall consist of:

- a) A warning flag that will be exposed with the battery removed and the cover closed,
- b) A hinged cover that cannot be closed with the battery removed,
- c) A swing-out or pull-out battery compartment that is resistant to being closed unless it has a battery in place,
- d) An audible or audible and tactile trouble signal on an AC powered carbon monoxide alarm with battery back-up,
- e) An arrangement to render the unit resistant to reinstallation, or
- f) A local audible, local audible and tactile, or local visual indication at the control panel.

7.2 Deactivation of the battery of a carbon monoxide alarm that uses a non-replaceable battery shall result in a readily apparent and prominent indication. The indication shall consist of one of the following:

- a) A warning flag that will be exposed with the battery removed and the cover closed;
- b) A hinged cover that cannot be closed with the battery removed;
- c) A swing-out or pull-out battery compartment that is resistant to being closed unless it has a battery in place;
- d) An audible or audible and tactile trouble signal on an AC powered carbon monoxide alarm with battery back-up;
- e) An arrangement to render the unit resistant to reinstallation; or
- f) A local audible, local audible and tactile, or local visual indication at the control panel.

7.3 If a warning flag, or equivalent, is employed to comply with the requirement of [7.1](#) or [7.2](#), it shall be marked as required in [89.7](#).

## 8 Alarm Reset/Silence Feature

8.1 Each single and multiple station carbon monoxide alarm shall be designed to be reset/silenced through a manual operation (on the alarm) by physically depressing the alarm reset/silence feature. The operation of the reset/silence feature shall silence the alarm signal and restore the alarm to its normal condition resulting in the alarm once again being able to sense carbon monoxide and alarm within the limits of the Sensitivity Test, Section 4.1. The alarm signal shall be reenergized within 6 minutes from the time the reset button is operated if the concentration of carbon monoxide surrounding the alarm remains at 70 ppm or greater.

8.2 When single station carbon monoxide alarms are configured in a multiple station connection (interconnection of two or more carbon monoxide alarms), the carbon monoxide alarm that initiates an alarm signal shall be designed to be reset/silenced through a manual operation by physically depressing the alarm reset/silence feature on the initiating alarm.

8.3 As an optional feature, the manufacturer is permitted to include an additional wireless communication remote reset/silencing feature. If included, and tested for compliance with the requirements outlined in 8.6, the wireless communication remote reset/silence feature may be activated through a remote device. The wireless communication feature shall be capable of providing additional instructions for the user to confirm his physical proximity to the initiating carbon monoxide alarm before resetting/silencing the alarm signal using the remote device.

8.4 A multiple-station interconnected carbon monoxide alarm that produces an alarm signal (wired, wireless, relay, audible and audible-visual) shall be permitted to be reset/silenced by any of the following:

- a) By activating the alarm reset/silence feature on any multiple station interconnected carbon monoxide alarm, provided the carbon monoxide alarm that initiated the alarm signal remains in alarm; or
- b) By physically depressing the alarm reset/silence feature on the initiating carbon monoxide alarm(s), as noted in 8.1; or
- c) By activating the wireless communication remote reset/silencing feature using a remote device.

8.5 Upon activation of an alarm signal from a carbon monoxide alarm in the multiple-station circuit, or reactivation of the alarm signal from the originating carbon monoxide alarm, all alarms in the multiple-station interconnect shall re-initiate their alarm signal.

8.6 Carbon monoxide alarms with a wireless communication remote device and employing a remote alarm reset/silence feature shall be tested in accordance with one of the following requirements:

- a) The remote transmission radio of the carbon monoxide alarm shall comply with FCC Part 15.249 and the following frequency and field strength requirements:

- 1) Frequency range
  - i) 2.4 GHz (2.4 GHz – 2.4835 GHz)
  - ii) 900 MHz (902 – 928 MHz)
  - iii) 5.8 GHz (5725 – 5875 MHz)

- 2) Field strength

- i) 94 dBuV/m @ 3 m

or

b) The remote transmission radio of the carbon monoxide alarm shall comply with FCC Part 15.247 and the following frequency and field strength requirements:

1) Frequency range

i) 2.4 GHz (2.4 GHz – 2.4835 GHz)

ii) 900 MHz (902 – 928 MHz)

iii) 5.8 GHz (5725 – 5875 MHz)

2) Field strength

i) 30 dBm (1 W) (using antennas with directional gains < 6 dBi)

or

c) The manufacturer shall provide a defined test procedure, test frequency and field strength in compliance with FCC regulations that demonstrate the open field (line of sight) transmission range of the carbon monoxide alarm does not exceed 984 feet (300 m).

## 9 Voltage Classification

9.1 Unless otherwise indicated, all voltage and current values contained in this standard are rms.

a) Extra-Low-Voltage Circuit – A circuit that has an AC voltage of not more than 30 volts AC (42.4 volts peak) and maximum power of 100 volt-amperes, such as supplied by a Class 2 transformer; or a circuit of not more than 30 volts DC supplied by a primary battery; or a circuit supplied by a combination of a transformer and fixed impedance, that as a unit, complies with all the performance requirements of a Class 2 transformer. A circuit that is derived from a supply circuit of more than 30 volts by connecting resistance or impedance, or both, in series with the supply circuit to limit the voltage and current, is not considered to be an extra-low-voltage circuit.

b) Hazardous-Voltage Circuit – A circuit having characteristics in excess of those of an extra-low-voltage circuit.

## 10 Lifetime

10.1 The unit (including the sensor) shall have a specified lifetime of at least 3 years from the date of manufacture, or from the date the unit is placed into service. The unit reliability shall be estimated with an in-service reliability measurement, see [84.2.2\(a\)](#). If the manufacturer bases the specified lifetime on the date that the unit is placed into service, this specification shall be substantiated with technical data documenting that performance degradation is not likely to occur prior to the unit being placed into service if the unit is placed into service within 18 months after manufacture. The selection of which basis is employed to define the beginning of specified lifetime may be contingent upon the technology of the sensor used in the unit.

## CONSTRUCTION

### 11 General

#### 11.1 Accessories

11.1.1 Unless specifically indicated otherwise, the construction requirements specified for an alarm shall apply also for any remote accessories with which it is to be employed.

## 11.2 Sensitivity adjustment

11.2.1 A field sensitivity adjustment, if provided, shall be accessible with the alarm installed as intended, marked to indicate the direction of sensitivity (high or low), and shall employ a mechanical stop at both extremes. Removal of a snap-on cover to gain access to the sensitivity control is allowable, if no hazardous voltage parts are able to be contacted by the user. Adjustment extremes shall not exceed the values given in [Table 41.1](#).

## 11.3 Supplementary signaling feature

11.3.1 A supplementary signaling feature, such as a transmitter for remote signaling, included integral with a single or multiple station carbon monoxide alarm, is to be compatible with the device(s) with which it is intended to be employed, and the remote signaling device(s) shall be acceptable for carbon monoxide alarm application.

## 12 Service and Maintenance Protection

### 12.1 General

12.1.1 An uninsulated live part of a hazardous-voltage circuit within the enclosure shall be located, guarded, or enclosed so as to reduce the risk of unintentional contact by persons performing service functions with the equipment energized.

12.1.2 An electrical component which may require examination, replacement, adjustment, servicing, or maintenance with the alarm energized shall be located and mounted with respect to other components and with respect to grounded metal so that it is accessible for such service without subjecting the user to an electric shock from adjacent uninsulated hazardous-voltage live parts.

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

- a) Coils of relays, solenoids, and transformer windings, if the coils and windings are provided with insulating overwraps,
- b) Terminals and splices with insulation rated for the intended application, and
- c) Insulated wire.

### 12.2 Sharp edges

12.2.1 An edge, projection or corner of an enclosure, opening, frame, guard, knob, handle, or the like, of a carbon monoxide alarm shall be smooth and rounded, so as not to cause a cut-type injury when contacted during use or user maintenance.

## 13 Enclosure

### 13.1 General

13.1.1 The enclosure of an alarm shall be constructed to resist the abuses encountered in service. The degree of resistance to abuse inherent in the alarm shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other defects that, alone or in combination, results in a risk of fire, electrical shock, or injury to persons.

13.1.2 Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be considered in determining compliance with the requirement of [13.1.1](#).

13.1.3 All electrical parts of an alarm, including a separate power supply, except for plug-in blades, shall be enclosed to provide protection against contact with uninsulated live parts. A separate enclosure for field-wiring terminals that will be enclosed by a junction box is not required.

13.1.4 There shall not be rear openings in a carbon monoxide alarm which are permeable to debris or air currents that affect alarm response.

13.1.5 There shall not be openings between the mounting surface to which an alarm is intended to be installed and the rear of the alarm which are permeable to air that affects alarm response.

13.1.6 To comply with [13.1.4](#) and [13.1.5](#), one of the following methods, or method determined to be equivalent, shall be used:

a) An elastomeric rubber or neoprene gasket, or the equivalent, may be placed between the rear of the alarm and the mounting surface to seal the rear openings or

b) Instructions in the installation manual may be provided to describe the location and method(s) of applying a sealing compound that has been determined to be acceptable for the intended use.

13.1.7 The enclosure of an alarm shall be provided with means for mounting in the intended manner. Any fittings, such as brackets, hangers, or the like, necessary for mounting shall be furnished with the alarm. The mounting means shall be accessible without disassembling any operating part of the alarm. The removal of a completely assembled panel or cover to mount the alarm is not considered to be disassembly of an operating part.

13.1.8 If the unit is intended for permanent connection in a hazardous voltage circuit, the enclosure shall either have provision for the connection of metal-clad cable, conduit, or nonmetallic sheathed cable, or have provision for mounting on an outlet box.

13.1.9 A mounting bracket, or other means provided to secure a detector system to a boat, shall be of a type and located so the installation maintains a fixed relationship to the boat when subjected to the vibration and shock loads of marine service. See [81.2.7](#) – [81.2.15](#).

13.1.10 Among the factors taken into consideration when a frame or enclosure for a detector system intended for a boat is judged are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

e) Resistance to ignition from electrical sources;

f) Resistance to corrosion; and

g) Resistance to distortion at temperatures to which the enclosure is subjected under conditions of normal or abnormal use.

13.1.11 Materials which are to be exposed to moist environments shall not be adversely affected when subjected to the humidity conditioning specified in [81.2.16](#) and [81.2.17](#).

## 13.2 Cast metal enclosures

13.2.1 The thickness of cast metal for an enclosure shall be as indicated in [Table 13.1](#). Cast metal having a thickness 1/32 inch (0.8 mm) less than that indicated in [Table 13.1](#) shall be employed only if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape and/or size of the surface is such that equivalent mechanical strength is provided.

**Table 13.1**  
**Cast Metal Enclosures**

Use, or dimensions of area involved	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast type,	
	inch	(mm)	inch	(mm)
Area of 24 square inches (155 cm <sup>2</sup> ) or less and having no dimension greater than 6 inches (152 mm)	1/16 <sup>a</sup>	(1.6)	1/8	(3.2)
Area greater than 24 square inches (155 cm <sup>2</sup> ) 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)

<sup>a</sup> The area limitation for metal 1/16 inch (1.6 mm) in thickness is able to be obtained by the provision of reinforcing ribs subdividing a larger area.

13.2.2 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, there shall not be less than 3-1/2 nor more than five threads in the metal, and the construction shall be such that a standard conduit bushing is able to be attached.

13.2.3 If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall not be less than 3-1/2 full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

## 13.3 Sheet metal enclosures

13.3.1 The thickness of sheet metal employed for the enclosure of an alarm shall not be less than that indicated in [Table 13.2](#) unless the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size of the surface is such that equivalent mechanical strength is provided.

**Table 13.2**  
**Sheet Metal Enclosures**

Maximum dimensions of enclosure				Minimum thickness of sheet metal					
				Steel				Brass or aluminum	
Length or width		Area		Zinc-coated		Uncoated			
inches	(mm)	inches <sup>2</sup>	(cm <sup>2</sup> )	inch	(mm)	inch	(mm)		
12	(305)	90	(581)	0.034	(0.86)	0.032	(0.81)	0.045	(1.14)
24	(610)	360	(2322)	0.045	(1.14)	0.042	(1.07)	0.058	(1.47)
48	(1219)	1200	(7742)	0.056	(1.42)	0.053	(1.35)	0.075	(1.91)
60	(1524)	1500	(9678)	0.070	(1.78)	0.067	(1.70)	0.095	(2.41)
Over 60	(Over 1524)	Over 1500	(Over 9678)	0.097	(2.46)	0.093	(2.36)	0.122	(3.10)

13.3.2 At any point where conduit or metal-clad cable is to be attached, sheet metal shall have a thickness of not less than 0.032 inch (0.81 mm) if of uncoated steel, not less than 0.034 inch (0.86 mm) if of galvanized steel, and not less than 0.045 inch (1.14 mm) if of nonferrous metal.

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

13.3.4 A closure for a hole larger than 1-3/8 inch (34.9 mm) diameter shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used.

13.3.5 A knockout in a sheet metal enclosure shall be secured but shall be capable of being removed without undue deformation of the enclosure.

13.3.6 A knockout shall be provided with a surrounding surface for seating of a conduit bushing, and shall be so located that installation of a bushing at any knockout used during installation will not result in spacings between uninsulated live parts and the bushing of less than those indicated in Spacings, Section [36](#).

#### 13.4 Nonmetallic enclosures

13.4.1 An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength and durability and be so formed that operating parts are protected against damage. The mechanical strength of the enclosure shall be at least equivalent to a sheet metal enclosure of the minimum thickness specified in [Table 13.2](#). See also the Tests of Thermoplastic Materials, Section [68](#).

13.4.2 The continuity of any grounding system to which an alarm is able to be connected shall not rely on the dimensional integrity of the nonmetallic material.

13.4.3 Polymeric material used for an enclosure shall comply with the following requirements:

- a) Enclosure containing parts presenting risk of fire – Minimum flammability rating of V-0, and complies with the performance requirements of the Flammability – 5 Inch Flame Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.
- b) Enclosures containing Class 2 and Class 3 circuits with a voltage not exceeding 30 V AC, 42.4 V-peak, or 60 V DC – Minimum flammability rating of HB, and complies with the performance requirements of the Flammability – 3/4 Inch Flame Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.
- c) Enclosures containing circuits powered by batteries with energy limited to 15 watts – Minimum flammability rating of HB.

#### 13.5 Ventilating openings

13.5.1 Ventilating openings in an enclosure for hazardous-voltage circuits including perforated holes, louvers, and openings protected by means of wire screening, expanded metal, or perforated covers, shall be of such size or shape that no opening permits passage of a rod having a diameter of 9/64 inch (3.6 mm). An enclosure for a fuse(s) or other overload protective device provided with ventilating openings shall afford protection against the emission of flame or molten metal. Openings provided to permit cleaning, or openings that are used to clean internal parts, shall be constructed to reduce the risk of damage to functional internal components during such cleaning operations.

13.5.2 Except as noted in [13.5.3](#), perforated sheet metal employed for expanded metal mesh shall not be less than 0.042 inch (1.07 mm) in average thickness, 0.046 inch (1.17 mm) if zinc coated.

13.5.3 If the indentation of the guard or enclosure does not alter the clearance between uninsulated live parts and grounded metal so as to reduce spacings below the minimum values required, 0.021 inch (0.53 mm) expanded metal mesh or perforated sheet metal, 0.024 inch (0.61 mm) if zinc coated, is able to be employed under the following conditions:

- a) The exposed mesh on any one side or surface of the product has an area of not more than 72 square inches (465 cm<sup>2</sup>) and has no dimension greater than 12 inches (305 mm<sup>2</sup>) or
- b) The width of an opening so protected is not greater than 3-1/2 inches (88.9 mm).

13.5.4 The wires forming a screen protecting hazardous-voltage parts shall not be smaller than 16 AWG (1.3 mm<sup>2</sup>) and the screen openings shall not be greater than 1/2 square inch (3.2 cm<sup>2</sup>).

## 13.6 Covers

13.6.1 An enclosure cover shall be hinged, sliding, pivoted, or similarly attached when:

- a) It provides ready access to fuses or any other overcurrent protective device, the intended protective functioning of which requires renewal or
- b) It is necessary to open the cover periodically in connection with the intended operation of the alarm. For the purpose of this requirement, intended operation is considered to be operation of a switch for testing or operation of any other component of an alarm that requires such action in connection with its intended performance. This requirement does not apply to the battery replacement aspect of an alarm employing a battery as the main or standby supply.

13.6.2 A cover that is intended to be removed only for periodic maintenance shall be secured by any one of the following or equivalent means: positive snap catch, plug-in or twist action, snap tab with one screw, or two or more screws.

13.6.3 If an alarm cover is not intended to be removed for cleaning, maintenance, or both, and the alarm is intended to be returned to the factory for servicing, the cover shall be secured so that it cannot be readily removed. Exposed screw slots or nuts, other than a tamperproof type, shall be sealed or covered.

*Exception: These requirements do not apply if the alarm cover is intended to be removed for cleaning, maintenance, or both, even though the alarm is intended to be returned to the manufacturer for servicing.*

13.6.4 A hinged cover is not required where the only fuse(s) enclosed is intended to provide protection to portions of internal circuits, such as employed on a separate printed-wiring board or circuit subassembly, to prevent circuit damage resulting from a fault. Such fuses shall not be used unless the word "CAUTION" and the following or equivalent marking is located on the cover of an alarm employing hazardous-voltage circuits: "Circuit Fuse(s) Inside – Disconnect Power Prior To Servicing."

13.6.5 A hinged cover shall be provided with a latch, screw, or catch to hold it closed. An unhinged cover shall be securely held in place by screws or a means determined to be equivalent.

## 13.7 Transparent panels

13.7.1 Glass covering an enclosure opening shall be held securely in place so that it cannot be displaced in service and shall provide mechanical protection of the enclosed parts. The thickness of a glass cover shall not be less than that indicated in [Table 13.3](#).

**Table 13.3  
Thickness of Glass Covers**

Maximum size of opening				Minimum thickness	
Length or width		Area			
inches	(mm)	inches <sup>2</sup>	(cm <sup>2</sup> )	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 footnote a	

<sup>a</sup> 1/8 inch (3.2 mm) or more, depending upon the size, shape, and mounting of the glass panel. A glass panel for an opening having an area of more than 144 square inches (929 cm<sup>2</sup>), 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.

13.7.2 A transparent material other than glass employed as a cover over an opening in an enclosure shall:

- a) Be mechanically equivalent to that of glass;
- b) Not distort; or
- c) Not become less transparent at the temperature to which it is subjected under normal service conditions.

13.7.3 A lens, light filter, or similar part of a carbon monoxide alarm shall be constructed of a material whose transparency will not be diminished by the conditions to which it will be exposed in service, as represented by the Performance Tests (see Sections 38 – 75) of this standard.

**14 Corrosion Protection**

14.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

14.2 The requirement of 14.1 applies to all sheet steel or cast iron enclosures, and to all springs and other parts upon which mechanical operation depends. It does not apply to minor parts, such as washers, screws, and bolts, if the failure of such unprotected parts does not result in a risk of fire or electric shock or injury to persons or impair the operation of the alarm. Parts made of stainless steel, polished or treated if necessary, do not require additional protection. Bearing surfaces shall be of materials that will prevent binding due to corrosion.

14.3 Metal shall not be used in combinations such as to cause galvanic action which will adversely affect cabinets or enclosures.

14.4 Hinges and other attachments shall be resistant to corrosion.

14.5 Nonferrous cabinets and enclosures do not require special corrosion protection.

**POWER SUPPLY**

**15 Primary Power Supply**

15.1 The primary power supply of a single or multiple station carbon monoxide alarm shall be either an electrical power source or a battery or batteries. Connection to the electrical power source, if used, shall be in the form of permanent wiring to terminals or leads in a separate wiring compartment (see also

[13.1.8](#)) having provision for the connection of conduit, metal-clad or nonmetallic sheathed cable, or by means of a power-supply cord and a two or three prong attachment plug.

15.2 If a separate power supply is provided, it shall have limited output energy consisting of an open circuit voltage not in excess of 30 volts rms, 42.4 volts peak or direct current (DC), and its output capacity shall be limited to a maximum of 100 volt-amperes. The energy shall be limited by an energy limited transformer having an output rating of 100 volt-amperes or less, or by a transformer plus additional circuitry having characteristics equivalent to those of a Class 2 transformer.

## **16 Secondary Power Supply (Not Applicable for Commercial Vehicles)**

16.1 The use of a secondary power supply is required for all alarms that receive their primary power from a source other than an integral battery or batteries. The secondary power supply, such as a battery, shall have the capacity to supply the maximum intended power to the alarm for 24 hours in the standby condition and thereafter be able to operate the alarm for an alarm signal for at least 12 hours continuously, followed by not less than 7 consecutive days of trouble signal.

16.2 If a battery is employed for the secondary power supply, it shall be of a rechargeable or nonrechargeable type. For a rechargeable type battery, the maximum charging current, as well as the maximum trickle charging current available, shall not exceed the battery manufacturer's specifications. For a nonrechargeable type battery, data on battery life, including discharge curves, shall be provided for the investigation to evaluate battery shelf aging and performance characteristics.

16.3 If a battery is employed as a secondary power supply, the marking on the unit shall include the manufacturer's specified periodic battery replacement instructions.

16.4 The discharge condition of a non-rechargeable or rechargeable type battery shall be monitored where a trouble indication, as described in [40.1.3](#), is obtained. The monitoring shall take place whether the alarm is operating on the primary supply or on the standby supply.

## **17 Batteries**

### **17.1 General**

17.1.1 If a battery or set of batteries is employed as the main source of power of a single or multiple station carbon monoxide alarm, it shall meet the requirements of the Battery Tests, Section [66](#).

17.1.2 Batteries included as part of an alarm shall be so located and mounted that terminals of cells will be prevented from coming in contact with uninsulated live parts, terminals or adjacent cells, or metal parts of the enclosure as a result of shifting.

17.1.3 A battery compartment intended for use with rechargeable batteries which emit gases during charging shall be provided with vent holes.

17.1.4 Ready access shall be available to the battery compartment to facilitate battery replacement, without damage to the alarm components or disassembly of any part of the alarm, except for a cover or the equivalent.

17.1.5 Connections of external wiring to a battery-operated single- or multiple-station carbon monoxide alarm, or to a portable accessory, shall not be subjected to stress or motion during battery replacement and/or servicing. Removal of the alarm or accessory from the mounting support to replace a battery or to service the unit is not allowed unless the connected wiring is not subjected to flexing or stress.

17.1.6 A carbon monoxide alarm powered by a non-replaceable battery shall be provided with a means of activating the power prior to installation and deactivating the battery at the end of the useful battery life. The deactivation means shall require the use of a tool, or equivalent, and shall render the unit resistant to being reinstalled. The deactivation means shall also serve to discharge the battery(ies) completely. Both the activation and deactivation means shall be designed to operate one time only. The installation instructions shall provide the user with information describing this one time operation. See [91.1\(u\)](#).

## 17.2 Battery connections

17.2.1 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs), and provided with strain relief. Indicating polarity on the unit adjacent to the battery terminals or leads is not prohibited.

17.2.2 Connections to battery terminals shall be either by a lead terminating in a positive snap action type of clip, or a fixed butt type connection which applies a minimum of 1.5 pounds (6.6 N) force to each battery contact, or equivalent. The connection shall consist of an unplated or plated metal which is resistant to the corrosive action of the electrolyte.

17.2.3 Each lead of a clip-lead assembly employed as part of a battery operated alarm shall be a minimum of 26 AWG (0.21 mm<sup>2</sup>) stranded wire with a minimum 1/64-inch (0.4-mm) insulation.

## 18 Supplementary Signaling Circuits

18.1 For a cord-connected or battery operated single station alarm employing a supplementary signaling circuit which is energized from a separate source of supply, the source of energy shall not exceed the energy limits defined in [74.2.1](#) and [74.2.2](#).

18.2 For an alarm intended to be connected to a fixed wiring system and employing a separately energized signaling circuit, the source of energy shall not exceed the limits in [74.2.1](#) unless the connections are made as a Class 1 wiring system as defined in the National Electrical Code, NFPA 70-1996, or in the Canadian Electrical Code, Part 1 (CSA C22.1).

## FIELD WIRING

### 19 Permanent Connection

#### 19.1 General

19.1.1 A single station or multiple station carbon monoxide alarm intended for permanent connection to a hazardous voltage circuit shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the National Electrical Code, NFPA 70-1996, or the Canadian Electrical Code, Part 1 (CSA C22.1), corresponding to the rating of the unit.

#### 19.2 Field-wiring compartment for hazardous voltage connection

19.2.1 The field-wiring compartment area is to be of sufficient size for completing all field-wiring connections as specified by the installation wiring diagram. There shall be space within the compartment to permit the use of a standard conduit bushing on conduit connected to the compartment if a bushing is required for installation.

19.2.2 Protection for internal components and wire insulation from sharp edges shall be provided by insulating barriers or metal barriers having smooth rounded edges.

### 19.3 Field-wiring terminals

19.3.1 Terminal parts to which field connections are to be made shall consist of binding screws with terminal plates having upturned lugs or a means determined to be equivalent to hold the wires in position. Other terminal connections shall not be provided unless determined to be equivalent.

19.3.2 If a wiring-binding screw is employed at a field-wiring terminal, the screw shall not be smaller than a No. 6 (3.5 mm diameter).

19.3.3 Except as noted in [19.3.4](#), a terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick and shall not have less than two full threads in the metal.

19.3.4 A terminal plate shall have the metal extruded at the tapped hole for the binding screw so as to provide two full threads. Other constructions shall be employed only if they provide equivalent security.

19.3.5 Wiring terminal assemblies that are used for field connections shall be prevented from turning.

### 19.4 Field-wiring leads

19.4.1 Power supply leads provided for field connection shall not be less than 6 inches (152 mm) long, provided with strain relief, and shall not be smaller than 18 AWG (0.82 mm<sup>2</sup>); and the insulation, if thermoplastic, shall not be less than 1/32 inch (0.8 mm) in thickness.

*Exception No. 1: The lead may be less than 6 inches long if it is evident that the use of a longer lead may result in damage to the insulation.*

*Exception No. 2: Solid copper leads as small as 26 AWG (0.13 mm<sup>2</sup>) may be used if:*

- a) The current does not exceed 1 ampere for lengths up to 2 feet (61 cm) and the current does not exceed 0.4 ampere for lengths up to 10 feet (3.05 m);*
- b) There are two or more conductors and they are covered by a common jacket or the equivalent;*
- c) The assembled conductors comply with the requirements of the Strain Relief Test, Section [73](#); and*
- d) The installation instructions indicate that the lead cannot be spliced to a conductor larger than 18 AWG.*

19.4.2 Leads provided for field connection to power limited signaling circuits, such as employed for multiple station interconnection or for connection to remote signaling devices, shall not be smaller than 16 AWG (1.3 mm<sup>2</sup>), for a single conductor, 19 AWG (0.65 mm<sup>2</sup>) for two or more conductors, and 26 AWG (0.13 mm<sup>2</sup>) for four or more conductors of a multiconductor cable. The conductor shall be solid, bunch tinned stranded, or stranded copper. Stranded copper wire, consisting of not more than seven strands, may be employed only for 18 AWG (0.82 mm<sup>2</sup>) and larger conductors.

### 19.5 Grounded supply terminals and leads

19.5.1 A field-wiring terminal for the connection of a neutral supply conductor shall be identified by means of a metallic plated coating substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of the terminal for the connection of the neutral conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

19.5.2 A field-wiring lead provided for connection of a neutral supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from other leads. No leads other than neutral conductors, shall be so identified.

19.5.3 A terminal or lead identified for the connection of the neutral supply conductor shall not be electrically connected to a single-pole manual switching device that has an OFF position or to a single-pole overcurrent (not thermal) protective device.

## 20 Power Supply Cord

20.1 A cord-connected single station carbon monoxide alarm shall be provided with not less than 6 feet (1.83 m) nor more than 20 feet (6.10 m) of flexible cord and a two or three prong attachment plug of the type and rating for connection to the supply circuit.

*Exception: The cord may be less than 6 feet in length if it is evident that the use of a longer cord:*

- a) *May result in a risk of fire or electric shock;*
- b) *May result in unintentional contact with moving parts that may cause a risk of injury to persons; and*
- c) *Is not required for the intended operation of the product.*

20.2 The flexible cord shall be of Type SP-1, SPT-1, SP-2, SPT-2, SV, SVT, SJ, SJT, SPE, SVE, or equivalent, minimum 18 AWG (0.82 mm<sup>2</sup>). It shall be rated for use at the voltage and ampacity rating of the alarm, in accordance with the National Electrical Code, NFPA 70, or the Canadian Electrical Code, Part 1 (CSA C22.1).

20.3 Means shall be provided to prevent the flexible cord from being pushed into the enclosure through the cord-entry hole if such displacement:

- a) Subjects the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is rated,
- b) Reduces spacings below the minimum acceptable values, or
- c) Results in damage in internal components.

20.4 A smoothly rounded restraining means shall be provided for securing the attachment plug to the receptacle. See the Strain Relief Test, Section [73](#).

20.5 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section [73](#).

20.6 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, and fins that may cause abrasion of the insulation on the conductors.

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