



UL 508

Underwriters Laboratories Inc.
Standard for Safety

Industrial Control Equipment



Documents

Document Sharing Hub

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

UL Standard for Safety for Industrial Control Equipment, UL 508

Seventeenth Edition, Dated January 28, 1999

Revisions: This Standard contains revisions through and including September 19, 2008.

Summary of Topics

Revisions are being issued to modify the scope to reference UL 1008 for assemblies constructed of two or more controllers intended to transfer power to a common output between multiple input sources.

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 new and/or revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated August 24, 2007.

The revisions dated September 19, 2008 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://ulstandardsinfo.net/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 © 2008 Underwriters Laboratories Inc.

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

Page	Date
1.....	September 19, 2008
2-4A.....	July 11, 2005
4B-5.....	December 12, 2002
6.....	September 19, 2008
6A.....	July 11, 2005
6B.....	December 12, 2002
6C.....	July 11, 2005
6D-9.....	December 12, 2002
10-11.....	January 22, 2001
12-12A.....	July 11, 2005
12B.....	December 12, 2002
13.....	August 22, 2000
14.....	January 22, 2001
15.....	August 22, 2000
16.....	July 11, 2005
17.....	December 2, 2003
18.....	September 19, 2008
19-20A.....	December 17, 2001
20B.....	August 22, 2000
21-22.....	July 11, 2005
23-24B.....	December 2, 2003
24C-28.....	July 11, 2005
29.....	January 28, 1999
30-32.....	July 11, 2005
33.....	January 22, 2001
34-36.....	December 2, 2003
36A.....	August 22, 2000
36B.....	July 16, 1999
37-38.....	January 28, 1999
39-41.....	December 2, 2003
42.....	July 11, 2005
42A.....	December 2, 2003
42B.....	July 11, 2005
42C-42D.....	December 2, 2003
43.....	December 12, 2002
44-44B.....	July 11, 2005
45-47.....	December 2, 2003
48.....	August 22, 2000
48A.....	December 2, 2003
48B-50.....	January 22, 2001
51-52.....	July 16, 1999
53.....	January 22, 2001
54-55.....	December 2, 2003
56.....	July 11, 2005
56A-56B.....	December 2, 2003
57-64B.....	July 11, 2005
65.....	August 22, 2000
66.....	December 2, 2003
67.....	August 22, 2000

68	December 2, 2003
68A-70A	July 11, 2005
70B	December 12, 2002
71	January 22, 2001
72	July 11, 2005
72A	January 22, 2001
72B	August 22, 2000
73	July 11, 2005
74-76	December 12, 2002
77	August 22, 2000
78-82	December 2, 2003
83	July 11, 2005
84	January 22, 2001
84A	December 12, 2002
84B-84C	January 22, 2001
84D-84E	July 11, 2005
84F	December 12, 2002
85	July 16, 1999
86	August 22, 2000
86A-88	December 2, 2003
89	July 16, 1999
90	January 22, 2001
91-92B	December 2, 2003
93-94	July 11, 2005
94A-94B	August 22, 2000
95	July 16, 1999
96-98	July 11, 2005
98A-98B	December 2, 2003
99	December 12, 2002
100	July 11, 2005
100A	August 22, 2000
100B	July 11, 2005
101	December 12, 2002
102	August 22, 2000
103-104B	December 2, 2003
105	July 16, 1999
106-106A	July 11, 2005
106B	December 12, 2002
107	January 28, 1999
108	July 16, 1999
109	July 11, 2005
110	August 22, 2000
110A	July 11, 2005
110B	December 12, 2002
110C-110D	July 11, 2005
111	July 16, 1999
112-112B	January 22, 2001
113	December 2, 2003
114-115	January 28, 1999
116	August 22, 2000
117-118	January 28, 1999
119-122D	September 19, 2008
123-124	December 2, 2003

125-126B	July 11, 2005
127	December 2, 2003
128-128A	August 22, 2000
128B-128J	July 11, 2005
129	January 28, 1999
130	August 22, 2000
130A	July 11, 2005
130B	August 22, 2000
131	December 2, 2003
132-132A	July 11, 2005
132B	December 2, 2003
133	December 12, 2002
134	January 28, 1999
134A-134D	July 11, 2005
135	December 12, 2002
136	July 11, 2005
136A-136B	December 12, 2002
137-140	January 22, 2001
141	July 11, 2005
142	December 12, 2002
143	July 11, 2005
144-144B	December 12, 2002
144C-144H	July 11, 2005
145-146	December 12, 2002
147-148	December 2, 2003
148A	December 17, 2001
148B	July 11, 2005
149	December 17, 2001
150	August 22, 2000
151	July 11, 2005
152	August 22, 2000
153	December 2, 2003
154	July 11, 2005
154A-154B	January 22, 2001
155	August 22, 2000
156-156A	July 11, 2005
156B-156C	December 17, 2001
156D	December 12, 2002
156E-156F	December 17, 2001
157-158	January 22, 2001
159-160	January 28, 1999
161-162B	July 16, 1999
163	January 28, 1999
164	December 12, 2002
164A-166B	July 11, 2005
167-170A	December 12, 2002
170B	July 11, 2005
171-172	January 28, 1999
173	January 22, 2001
174	January 28, 1999
175	January 22, 2001
176	July 11, 2005
176A-176B	January 22, 2001

177.....	July 16, 1999
178.....	January 28, 1999
179.....	January 22, 2001
180-181.....	July 11, 2005
182-182B.....	January 22, 2001
183.....	July 16, 1999
184-185.....	January 28, 1999
186-186B.....	January 22, 2001
187.....	July 11, 2005
188-188A.....	January 22, 2001
188B.....	December 2, 2003
189.....	January 28, 1999
190.....	July 11, 2005
191.....	January 22, 2001
192.....	January 28, 1999
193-195.....	December 12, 2002
196.....	August 22, 2000
196A-196F.....	July 11, 2005
197.....	January 28, 1999
198.....	July 16, 1999
199-200.....	January 28, 1999
201-202.....	December 2, 2003
203.....	January 22, 2001
204.....	December 2, 2003
204A-204B.....	January 22, 2001
205.....	January 28, 1999
206-207.....	December 2, 2003
208.....	January 28, 1999
SA1-SA4.....	January 28, 1999
A1-A2.....	July 11, 2005
B1.....	January 22, 2001
B2-B3.....	December 12, 2002
B4.....	August 22, 2000
B5-B6.....	July 16, 1999
B7.....	December 12, 2002
B8-B10.....	January 22, 2001
B11-B15.....	July 16, 1999
B16.....	August 22, 2000
B17-B18.....	July 11, 2005

No Text on This Page

JANUARY 28, 1999
(Title Page Reprinted: September 19, 2008)



ANSI/UL 508-2008

1

UL 508

Standard for Industrial Control Equipment

First Edition – September, 1925
Second Edition – March, 1928
Third Edition – June, 1931
Fourth Edition – February, 1933
Fifth Edition – August, 1933
Sixth Edition – May, 1934
Seventh Edition – July, 1938
Eighth Edition – May, 1956
Ninth Edition – December, 1962
Tenth Edition – September, 1964
Eleventh Edition – August, 1971
Twelfth Edition – May, 1977
Thirteenth Edition – December, 1983
Fourteenth Edition – August, 1984
Fifteenth Edition – September, 1989
Sixteenth Edition – February, 1993

Seventeenth Edition

January 28, 1999

The most recent designation of ANSI/UL 508 as an American National Standard (ANSI) occurred on September 19, 2008.

This ANSI/UL Standard for Safety, which consists of the Seventeenth edition, with revisions through September 19, 2008, is under continuous maintenance, whereby each revision is ANSI approved upon publication.

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.

The Department of Defense (DoD) has adopted UL 508 on June 5, 1989. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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>.

COPYRIGHT © 1977, 2008 UNDERWRITERS LABORATORIES INC.

No Text on This Page

CONTENTS

INTRODUCTION

1 Scope	17
2 Glossary	19
3 Units of Measurement	20A
4 Components	20B
5 Installation and Operation Instructions	21

PART I – ALL EQUIPMENT

ENCLOSURE CONSTRUCTION

6 Frames and Enclosure	21
6.1 General	21
6.2 Cast metal	21
6.3 Sheet metal	22
6.4 Doors and covers	24B
6.5 Polymeric	26
6.6 Bonding	27
6.7 Resistance measurement	30
6.8 Openings in enclosure	31
6.9 Ventilating openings	31
6.10 Barriers used with ventilation openings	32
6.11 Forced ventilation	34
6.12 Observation windows	34
6.13 Transformer or autotransformer	34
6.14 Motor controller wire bending space	34
6.15 Specific enclosures	34A
6.16 Components for use on specific enclosures	34D
6.17 Accessibility of live parts	35
7 Protection Against Corrosion	37
7.1 General	37
7.2 Outdoor enclosures	40

ENCLOSURE PERFORMANCE

8 General	40
9 Securement of Snap-On Cover Test	41

INSTRUCTIONS AND MARKINGS PERTAINING TO ENCLOSURES

10 Permanence of Marking	42
11 Details	42

DEVICE CONSTRUCTION

12	General	42B
13	Protection Against Corrosion	42B
14	Provisions for Mounting	42B
15	Insulating Material	42B
16	Means for Switching	44
17	Live Parts	44
18	Protective Devices	45
18.1	General	45
18.2	Protection of internal primary and secondary control circuit conductors	45
18.3	Protection of control circuit transformer	48A
18.4	Low-voltage protection	48B
18.5	Open-phase protection	49
18.6	Phase-reversal protection	49
19	Capacitors	49
20	Fuseholders	49
21	Internal Wiring	50
21.1	General	50
21.2	Routing of internal wiring	51
21.3	Clamps and guides	51
21.4	Flexing of internal wiring	51
21.5	Additional insulation	51
21.6	Splices and connections	51
21.7	Splice insulation	52
22	External Interconnections	52
22.1	Open equipment	52
22.2	Enclosed equipment	52
22.3	Interconnecting cords and cables	52
23	Transformers	53
24	Blower Motors	53
25	Supply Connections	53
25.1	General	53
25.2	Permanently connected equipment	54
25.3	Tapped holes for conduit	54
25.4	Knockouts	54
25.5	Size of wiring terminals and leads	54
25.5A	Evaluation of pressure wire connectors	56
25.5B	Evaluation of quick connect terminals	57
25.5C	Evaluation of wire binding screws	58
25.5D	Evaluation of field wiring leads	58
25.5E	Evaluation of spring type terminations	58A
25.6	Cord-connected equipment	58A
26	Cord-Connected Programming and Diagnostic Units	58C
27	Coil Windings	58D
28	Risk of Electric Shock	58D
29	Risk of Fire	58D
30	Lithium Battery Circuits	59
31	Non-Lithium Battery Circuits	59
31.1	General	59
31.2	Primary non-rechargeable	60
31.3	Secondary rechargeable/non-rechargeable	60
32	Isolated Secondary Circuits	60

32.1	General	.60
32.2	Differences between the level of evaluation required within each type of secondary circuit	.63
32.3	Class 2 circuit requirements	.63
32.4	Limited voltage/current circuit requirements	.63
32.5	Limited voltage circuit requirements	.64
32.6	Isolated power supply circuit requirements	.64A
32.7	Limited energy circuit requirements	.65
32.8	Limiting impedance circuit requirements	.65
33	Limited Voltage Primary Circuit	.67
33.1	General	.67
33.2	Overcurrent protection— primary circuits	.67
33.3	Overcurrent protection – secondary circuits	.67
34	Separation of Circuits	.68
35	Isolation Devices	.68A
36	Spacings	.68A
37	Insulating Barriers	.74
38	Clamped Insulating Joints in Lieu of Spacings	.75
39	Clearance and Creepage Distances	.77
39A	Protection of Service Personnel	.78
40	Grounding	.79
40.1	General	.79
40.2	Internal insulated bonding, grounding, and grounded circuit conductors	.81
40.3	Transformer secondary grounding	.81
41	Accessories	.82

DEVICE PERFORMANCE

42	General	.83
43	Temperature Test	.84A
44	Overvoltage and Undervoltage Test	.89
45	Overload Test	.89
46	Endurance Test	.94A
47	Endurance Test for Relays for Television Applications	.98
48	Calibration Test	.98
49	Dielectric Voltage-Withstand Test	.99
49.1	General	.99
49.2	Coils	.100
49.3	Secondary circuits	.100A
50	Short Circuit Test – General	.100A
50.1	General	.100A
50.2	Enclosure	.101
50.3	Sample preparation	.103
50.4	Group fusing	.104
51	Standard Fault Current Circuits	.104
51.1	Protective devices	.104
51.2	Sample selection for overload relay	.106
51.3	Parameters	.106A
52	High-Available Fault Current Circuits (Optional)	.108
52.1	General	.108
52.2	Sample selection	.108
52.3	Procedure	.110
52A	Group Installation (Optional)	.110A

52A.1 General	110A
52A.2 Sample selection	110B
52A.3 Group installation for standard fault circuit ratings	110C
52A.4 Group installation for high capacity short circuit ratings	110C
53 Standard and High Fault Acceptance Criteria	110C

No Text on This Page

54	Calibration of Test Circuits	110D
54.1	Circuit characteristics	110D
54.2	Alternating-current circuits	112
54.3	Direct current circuits	116
54.4	Instrumentation for test currents above 10,000 amperes	117
54.5	Calibration characteristics for protective device	118
55	Transient-Voltage-Surge Suppression Test	121
56	Accelerated Aging Test	122A
57	Breakdown of Components Test	122A
57A	Strain Relief Test	122B
57B	Push-Back Relief Test	122B
58	Wire Flexing	122B
59	Terminal Torque Test	122C
60	Printed Wiring Board Abnormal Operation Test	122C
61	Secondary Circuits Test	123
61.1	General	123
61.2	Limited voltage/current secondary test	125
61.3	Limited energy secondary test	126
61.4	Isolated power supply capacity test	126
61.5	Limited voltage secondary test	126
61.6	Limiting impedance test	126A
61A	Leakage Current Test	127
61B	Protection Against Contact with Live Parts of Door Mounted Components Test	128B
61C	Electronic Ballasts	128B

DEVICE RATING

62	Details	128F
----	---------------	------

MARKING

63	General	128H
64	Wiring Terminal Markings	130A
65	Cautionary Markings	132

INSTRUCTIONS AND MARKINGS PERTAINING TO ACCESSORIES

66	Details	134
67	Marking Location	134

MANUFACTURING AND PRODUCTION TESTS

67A	Production-Line Dielectric Voltage-Withstand Test	137
67B	Production-Line Grounding-Continuity Test	139
67C	Production-Line Polarization-Continuity Test – Cord and Plug Connected Equipment	139

PART II – MAGNETIC MOTOR CONTROLLERS

CONSTRUCTION

68	General	139
----	---------------	-----

PERFORMANCE

69 General	140
------------------	-----

RATING

70 Details	140
------------------	-----

MARKING

71 Marking	140
------------------	-----

PART III – MANUAL MOTOR CONTROLLERS**CONSTRUCTION**

72 General	140
------------------	-----

PERFORMANCE

73 General	141
73A Temperature Test	143
73B Endurance Test (Motor Disconnect)	143
73C Dielectric Voltage Withstand Test	144
73D Short Circuit Test (Motor Disconnect)	144
73E Voltage-Withstand Test (Disconnect)	144A
73F Magnetic Trip Out Test	144A
73G Calibration – 200 Percent	144B
73H Short Circuit Tests for Tap Conductor Protection	144B
73H.1 Short circuit interrupting ability	144B
73H.2 High fault short circuit test	144B

RATING

74 Details	144B
------------------	------

MARKING

75 Details	144C
------------------	------

PART IV – COMBINATION MOTOR CONTROLLERS**CONSTRUCTION**

76 General	144D
------------------	------

PERFORMANCE

77 General	145
77A Temperature Test	148A
77B Dielectric Voltage Withstand Test	148B
78 Current Withstand Test	148B
79 Contactor Overload Test	148B
80 Voltage-Withstand Test	150
81 Magnetic Trip-Out Test	150
82 Combination Short Circuit Test	151
82A Interrupting Ability (Short Circuit) Test	152
83 Endurance Test	156
84 Calibration Test – 200 Percent	156
85 High Available Short Circuit Current Test	156
86 Coordination Test	156A

RATINGS

87 Details	156A
------------------	------

MARKING

88 Details	156B
------------------	------

PART V – REDUCED-VOLTAGE STARTERS**CONSTRUCTION**

89 General	156E
------------------	------

PERFORMANCE

90 Operation Test	156E
91 Duty Cycle Test	156F

RATINGS

92 Details	157
------------------	-----

MARKING

93 Details	158
------------------	-----

PART VI – SOLID-STATE AC MOTOR CONTROLLERS**CONSTRUCTION**

94 General	158
------------------	-----

PERFORMANCE

95 General	158
96 Temperature Test	160
97 Dielectric Voltage-Withstand Test	160
98 Overvoltage and Undervoltage Test	160
99 Overload Test	160
100 Endurance Test	160
101 Short Circuit Test	161
101.1 Evaluation of short circuit test	161
101.2 Selection of samples	161
101.3 Test procedure	161
101.4 Test circuit	162
102 Breakdown of Components Test	162
103 Operation Tests	162
103.1 General	162
103.2 Controller overload	162A
103.3 Single phasing	163
103.4 Inoperative blower motor	163
103.5 Clogged filter	163
103.6 Current limiting control	163

RATING

104 Details	163
-------------------	-----

MARKING

105 Details	164
-------------------	-----

PART VII – FLOAT- AND PRESSURE-OPERATED SWITCHES**GENERAL**

105A Glossary	164
---------------------	-----

CONSTRUCTION

106 General	164
107 Supply Connections – Permanently-Connected Devices	164A
108 Supply Connections – Cord- and Plug-Connected Devices	164A

PERFORMANCE

109 General	164B
110 Overload Test	165
111 Endurance Test	165
112 Pressure Tests	166
112.1 General	166
112.2 Parts contained in an enclosure	166A
112.3 Parts not contained in an enclosure	167
113 Hub and Nipple Tests	167

113.1	General	167
113.2	Pullout	168
113.3	Bending	168
113.4	Torque	168
114	Float Switch Tests	168
114.1	General	168
114.2	Immersion	169
114.3	Dielectric voltage-withstand	170
114.4	Tensile strength and ultimate elongation	170
114.5	Insulation resistance test	170

RATING

115	Details	170B
-----	---------------	------

MARKING

116	Details	170B
-----	---------------	------

PART VIII – SEMICONDUCTOR RELAYS AND SWITCHES

CONSTRUCTION

117	General	170B
-----	---------------	------

PERFORMANCE

118	General	171
119	Temperature Test	171
120	Overvoltage and Undervoltage Test	172
121	Overload Test	172
122	Endurance Test	172
123	Dielectric Voltage-Withstand Test	172
124	Breakdown of Components Test	172

RATING

125	Details	173
-----	---------------	-----

MARKING

126	General	173
-----	---------------	-----

No Text on This Page

PART IX – MERCURY TUBE SWITCHES**CONSTRUCTION**

127 General	173
-------------------	-----

PERFORMANCE

128 General	173
129 Overvoltage and Undervoltage Test	174
130 Short Circuit Test	174

RATING

131 Details	175
-------------------	-----

MARKING

132 Details	175
-------------------	-----

PART X – AUXILIARY DEVICES**CONSTRUCTION**

133 General	175
-------------------	-----

PERFORMANCE

134 General	175
135 Temperature Test	176A
136 Overvoltage and Undervoltage Test	177
137 Overload Test	177
138 Endurance Test	179

RATING

139 Details	180
-------------------	-----

MARKING

140 Details	181
-------------------	-----

PART XI – MECHANICAL OVERLOAD RELAYS**CONSTRUCTION**

141 General	182
-------------------	-----

PERFORMANCE

142 General	182
143 Overload Test	182A
144 Endurance Test	183

RATING

145 Details	183
-------------------	-----

MARKING

146 Details	184
-------------------	-----

PART XII – ELECTRONIC OVERLOAD RELAYS**CONSTRUCTION**

147 General	185
-------------------	-----

PERFORMANCE

148 General	186
149 Short-Circuit Test for Devices Provided with a Current Transformer	186A
150 Short-Circuit Test for Devices Not Provided with a Current Transformer	186A
151 Calibration Test	186A
152 Breakdown of Components Test	186A

RATING

153 Details	186A
-------------------	------

MARKING

154 Details	186A
-------------------	------

PART XIII – DEFINITE PURPOSE CONTROLLERS**CONSTRUCTION**

155 General	186B
-------------------	------

PERFORMANCE

156 General	186B
157 Overvoltage and Undervoltage Test	187
158 Overload Test	187
159 Endurance Test	188
160 Locked Rotor Endurance Test	188B
161 Part Winding Endurance Test	189
162 Short Circuit Test	189

RATING

163 Details	190
-------------------	-----

MARKING

164 Details	191
-------------------	-----

PART XIV – SERVICE EQUIPMENT

165 General	191
-------------------	-----

PART XV – LAMP DIMMERS**CONSTRUCTION**

166 General	191
-------------------	-----

PERFORMANCE

167 General	191
168 Temperature Test	192
169 Operation Test	192
170 Overload Test	192

RATING

171 Details	193
-------------------	-----

MARKING

172 Details	193
-------------------	-----

PART XVI – MISCELLANEOUS DEVICES**Construction**

173 General	193
-------------------	-----

PERFORMANCE

173A General	194
173B Input Test	195
174 Temperature Test	195
174A Normal Operation Test	196
174B Abnormal Operation Test	196A
174C Burnout Test	196A
174D Inoperative Blower Motor Test	196B

RATING

175 Details	196B
-------------------	------

MARKING

176 Details	196C
-------------------	------

PART XVII – PROGRAMMABLE CONTROLLERS**GENERAL**

177 Details	196C
178 Glossary	196C

CONSTRUCTION

179 General	196C
180 Spacings	196D
181 Separation of Circuit Barriers	196E
182 Bonding	197

PERFORMANCE

183 General	197
184 Temperature Test	198
185 Overvoltage and Undervoltage Test	198
186 Overload Test	198
187 Endurance Test	199
188 Dielectric Voltage-Withstand Test	199
189 Breakdown of Components Test	199
190 Impedance Test	199

RATING

191 Details	200
-------------------	-----

MARKING

192 Details	201
193 Signal Circuits	201

PART XVIII – EQUIPMENT RATED 601– 1500 VOLTS**GENERAL**

194 Details	201
-------------------	-----

CONSTRUCTION

195 General	201
196 Insulating Material	202
197 Spacings	202

PERFORMANCE

198 General	202
199 Short Circuit Test	202
200 Dielectric Voltage-Withstand Test	202

No Text on This Page

PART XIX – PROXIMITY SWITCHES**GENERAL**

201 Details	203
202 Glossary	203

CONSTRUCTION

203 General	203
-------------------	-----

PERFORMANCE

204 General	204
205 Infrared Radiation	204
206 Power-Supply Cord Tests	204
206.1 General	204
206.2 Tensile strength and elongation tests	204A
206.3 Oven conditioning	205
206.4 Oil conditioning	205
206.5 Ultraviolet light (UV) conditioning	205
206.6 Cold bend test	205
207 Cable Gland Connector Tests	205
207.1 General	205
207.2 Oven conditioning (rubber composition)	206
207.3 Oven conditioning (thermoplastic composition)	206
207.4 Flexing test	206
207.5 Strain relief test	206
208 Strain Relief Test	206
209 Tests for Environmental Type Enclosures	206

RATING

210 Details	207
-------------------	-----

MARKING

211 Details	207
-------------------	-----

SUPPLEMENT SA - INDUSTRIAL CONTROL EQUIPMENT FOR MARINE USE

SA1 Scope	SA1
SA2 Enclosure	SA1
SA3 Current-Carrying Parts	SA2
SA4 Autotransformer Starters	SA2
SA5 Heater Circuits	SA2
SA6 Insulating Materials	SA2
SA7 Overcurrent Devices	SA2
SA8 Temperature Rating	SA2
SA9 Marking	SA2

APPENDIX A

Standards for Components.....	A1
-------------------------------	----

INDEX

This page intentionally left blank.

INTRODUCTION

1 Scope

1.1 These requirements cover industrial control devices, and devices accessory thereto, for starting, stopping, regulating, controlling, or protecting electric motors. These requirements also cover industrial control devices or systems that store or process information and are provided with an output motor control function(s). This equipment is for use in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements cover devices rated 1500 volts or less. Industrial control equipment covered by these requirements is intended for use in an ambient temperature of 0 – 40°C (32 – 104°F) unless specifically indicated for use in other conditions.

1.3 *Deleted December 2, 2003*

1.4 Examples of industrial control devices described in 1.1 are:

- a) Manual, magnetic, and solid-state starters and controllers.
- b) Thermal, magnetic, and solid-state overload relays.
- c) Pushbutton stations, including selector switches and pilot lights.
- d) Control circuit switches and relays.
- e) Float, flow, pressure, and vacuum-operated switches.
- f) Resistors and rheostats.
- g) Proximity switches.
- h) Time-delay relays and switches.
- i) Resistors and rheostats intended for industrial heating and lighting, including those for motor generator fields.
- j) Control devices intended for industrial heating and lighting.
- k) Solid-state time-delay relays.
- l) Programmable controllers.
- m) Numerical control systems.
- n) Lighting dimmer systems and controls.
- o) Mercury-tube switches.
- p) Definite purpose controllers.
- q) Solid-state logic controllers.

- r) Industrial microprocessor/computer systems.
- s) Variable voltage autotransformer.
- t) Motor starting autotransformer.

1.5 Industrial control panels are covered by the requirements in the Standard for Industrial Control Panels, UL 508A.

1.5 revised December 2, 2003

1.6 Fire pump controllers are covered by the requirements in the Standard for Fire Pump Controllers, UL 218.

1.6 revised December 2, 2003

1.7 An adjustable-speed drive and accessories or modules for use with an adjustable-speed drive are covered by the Standard for Power Conversion Equipment, UL 508C.

1.8 Equipment intended for use in hazardous locations as defined by the National Electrical Code, NFPA 70, are covered by the Standard for Industrial Control Equipment for Use in Hazardous (Classified) Locations, UL 698.

1.9 Devices that regulate temperature and/or control refrigeration equipment are covered by the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, and other applicable standards.

1.10 Electrical instruments are covered by the Standard for Electrical Analog Instruments— Panel Board Types, UL 1437.

1.11 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.11 revised August 22, 2000

1.12 Products consisting of interlocked controllers and similar assemblies, intended to transfer power to a common load or output between multiple inputs or sources, are covered by the Standard for Transfer Switch Equipment, UL 1008.

1.12 added September 19, 2008

2 Glossary

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

2.2 AMBIENT TEMPERATURE – The temperature of the air medium into which the heat of the equipment is dissipated. See 43.15.

2.2.1 AMBIENT TEMPERATURE RATING – A rating assigned to equipment that refers to the maximum ambient temperature of the room or space outside of the device enclosure or intended enclosure. See 43.16.

2.2.1 added July 16, 1999

2.3 CLOSED-OPEN OPERATION – An operation of closing the test device on the circuit. The letters "CO" signify this operation.

2.4 COMBINATION CONTROLLER – An open or enclosed device containing both a magnetic or solid-state controller and a disconnecting means. The controller may or may not contain overload protection, short circuit protection, or both. Where an individual controller is enclosed, it includes an external means for operating the disconnecting means.

2.4 revised December 17, 2001

2.5 COMBINATION MOTOR CONTROLLER – A controller intended for motor service that provides a disconnecting means, branch circuit (short-circuit and ground fault) protection, motor controller, and motor overload protection. In addition, where an individual controller is enclosed, it includes means for locking the disconnecting device in the "OFF" position.

2.5 revised December 17, 2001

2.5.1 COMPONENT FOR GROUP INSTALLATION – A motor control, overload relay, or other switching device evaluated for use in group installation. See 2.11.1.

2.5.1 added July 16, 1999

2.6 CONTACTOR – A two-state (ON-OFF) device for repeatedly establishing and interrupting an electric power circuit. Interruption is obtained by introducing a gap or a very large impedance.

2.7 CONTROL CIRCUIT – A circuit that carries the electric signals directing the performance of a controller, but which does not carry the main power circuit (see IEEE Standards Dictionary of Electrical and Electronic Terms). A control circuit is generally limited to 15 amperes.

2.8 CONTROLLER – A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

2.8.1 COVER – An unhinged portion of an enclosure that covers an opening.

2.8.1 added August 22, 2000

2.8.2 DOOR – A hinged portion of an enclosure that covers an opening.

2.8.2 added August 22, 2000

2.9 END-OF-LINE ENCLOSURE – An enclosure that is intended to be connected at the end of a run of conduit.

2.10 GENERAL PURPOSE RATING – This term is synonymous with "General Use Rating."

2.11 GENERAL USE RATING – A rating expressed in volts and amperes assigned to a device that is intended to control:

- a) A load with a continuous or inrush ampere rating not exceeding the ampere rating of the device;
- b) If AC rated, a load that has a power factor of 0.75 to 0.80 (inductive); and
- c) If DC rated, a load that is resistive (noninductive).

2.11.1 GROUP INSTALLATION – A motor branch circuit for two or more motors, or one or more motors with other loads and protected by a circuit breaker or a single set of fuses.

Added 2.11.1 effective July 16, 2001

2.12 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolating source (such as a transformer, optical isolator, limiting impedance or electro-mechanical relay) and having no direct connection back to the primary circuit (other than through the grounding means). A secondary circuit that has a direct connection back to the primary circuit is considered part of the primary circuit.

2.12.1 MANUAL CONTROLLER – A hand-operated switching device whose contacts are controlled by the position of a mechanical actuator.

2.12.1 added July 16, 1999

2.12.2 MANUAL CONTROLLER WITH INSTANTANEOUS TRIP – A manual controller provided with an instantaneous trip element for short circuit protection only and optionally provided with an overload relay.

2.12.2 added July 16, 1999

2.13 MOTOR CONTROL DEVICE – Any product or equipment rated in horsepower and/or full load-locked rotor current capable of interrupting the maximum operating overload current of a motor of the same horsepower or full load-locked rotor current rating as the product or equipment at the rated voltage. Such devices may include, but is not limited to, contactors, controllers, starters, and switches.

2.14 NON-COMBINATION MOTOR CONTROLLERS – Motor control devices of the non-combination type are for use with separate protective devices, such as fuses or inverse-time circuit breakers, installed in the supply side of the motor control device.

2.15 OPEN OPERATION – An operation of closing the circuit on the test device. The letter "O" signifies this operation.

2.16 PILOT DUTY – The rating assigned to a relay or switch that controls the coil of another relay or switch.

2.17 POLE LEAST LIKELY TO STRIKE GROUND – A pole that is referenced to ground or by virtue of its position or potential or both relative to other poles of the device to be less likely than any other to strike ground. In a three pole device, this pole would usually be the middle pole. It is possible for several poles to be equally least likely to strike to ground. In this case any may be used for the test.

2.18 POLLUTION DEGREE 1 – No pollution or only dry, nonconductive pollution occurs. The pollution has no influence.

2.19 POLLUTION DEGREE 2 – Normally, only nonconductive pollution occurs; however, temporary conductivity caused by condensation may be expected.

2.20 POLLUTION DEGREE 3 – Conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation that is expected.

2.21 PRIMARY CIRCUIT – A circuit in which the wiring and components are conductively connected to the branch circuit.

2.22 RECOVERY VOLTAGE – The voltage impressed upon the equipment under test after a circuit is cleared.

2.22.1 SELF-PROTECTED – A qualifying term applied to a controller that contains coordinated overload and short circuit protection. A self-protected controller is evaluated as a complete unit whether comprised of a single or multiple components. Coordinated protection is able to be inherent or obtained by correct selection of components or accessory parts in accordance with the manufacturer's instructions.

2.22.1 added August 22, 2000

2.23 STARTER – A form of controller that includes the switching means necessary to start and stop the connected load in combination with suitable overload protection.

2.23.1 SURROUNDING AIR TEMPERATURE RATING – A rating assigned to open type equipment that refers to the maximum ambient temperature of air immediately surrounding the equipment inside of the ultimate enclosure. See 43.16.

2.23.1 added July 16, 1999

2.24 SWITCH – A device for opening and closing, and for changing the connections of a circuit. A switch is understood to be manually-operated, unless otherwise stated.

2.25 TRANSIENT SUPPRESSIVE DEVICE – A component or assembly that limits the transient voltage such as an overvoltage protective device, a transformer with isolated windings, or a damping impedance suitably located.

3 Units of Measurement

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

3.1 revised August 22, 2000

4 Components

4.1 Except as indicated in 4.2, 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.

4.1 revised August 22, 2000

4.2 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.

4.2 revised August 22, 2000

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

4.3 revised August 22, 2000

4.4 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.

4.4 revised August 22, 2000

5 Installation and Operation Instructions

5.1 Literature intended to accompany a product, such as installation, rating, operation, and user-maintenance instructions or manuals shall be reviewed in the investigation of the product if the safe use of the product is dependent on the instructions. Since the literature is to be reviewed in the examination and test of the product, a draft copy of the literature may be used instead of a printed copy.

PART I – ALL EQUIPMENT

ENCLOSURE CONSTRUCTION

6 Frames and Enclosure

6.1 General

6.1.1 An enclosure of industrial control equipment shall be constructed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without total or partial collapse resulting in a risk of fire, electric shock, or injury to persons due to reduction of spacings, loosening or displacement of parts, or other serious defects.

6.1.2 Industrial controls with incomplete or partial enclosures are considered as open devices with respect to the performance requirements in this standard.

6.1.3 An enclosure shall be constructed so as to reduce the risk of unintentional contact with enclosed electrical devices, and to provide internal devices with protection from specified external conditions.

6.2 Cast metal

6.2.1 A cast-metal enclosure shall be at least 1/8 inch (3.2 mm) thick at every point, more than 1/8 inch thick at reinforcing ribs and door edges, and at least 1/4 inch (6.4 mm) thick at tapped holes for conduit.

Exception: Other than at plain or threaded conduit holes, reinforcing ribs, and door edges, malleable iron and die-cast or permanent mold cast aluminum, brass, bronze, or zinc shall be:

a) At least 3/32 inch (2.4 mm) thick for an area greater than 24 square inches (155 cm²) or having any dimension more than 6 inches (152 mm) and

b) At least 1/16 inch (1.6 mm) thick for an area of 24 square inches or less having no dimension more than 6 inches. The area considered may be bounded by reinforcing ribs subdividing a larger area.

6.2.1 revised July 11, 2005

6.2.2 The above thicknesses may be reduced if the enclosure complies with the Crushing Resistance Test and Resistance to Impact Test in accordance with the Standard for Polymeric Materials for Use in Electrical Equipment Evaluations, UL 746C, except that the required ball impact force is 13.6 J (10 lb-ft) for enclosure surfaces greater than 40 in², and the Polymeric Enclosure Rigid Metallic Conduit Connection Tests per the Standard for Enclosures for Electrical Equipment, UL 50.

6.2.2 added July 11, 2005

6.3 Sheet metal

6.3.1 The thickness of a sheet-metal enclosure shall not be less than that specified in Tables 6.1 and 6.2, except that at points to which a wiring system is to be connected, uncoated steel shall be at least 0.032 inch (0.81 mm) thick, and nonferrous metal at least 0.045 inch (1.14 mm) thick.

Exception: Enclosure thickness at points other than where a wiring system is to be connected may be less than 0.032 inch (0.81 mm) if the enclosure complies with the requirements in Sections 28 and 29 of the Standard for Enclosures for Electrical Equipment, UL 50.

6.3.1 revised July 11, 2005

6.3.2 Tables 6.1 and 6.2 are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

Table 6.1
Thickness of sheet metal for enclosures – carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcement ^a		Minimum acceptable thickness, Uncoated	
Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Maximum width ^b Inches (cm)	Maximum length Inches (cm)	Inches	(mm)
4.0 (10.2)	Not limited	6.25 (15.9)	Not limited	0.020 ^d	(0.51)
4.75 (12.1)	5.75 (14.6)	6.75 (17.1)	8.25 (21.0)		
6.0 (15.2)	Not limited	9.5 (24.1)	Not limited	0.026 ^d	(0.66)
7.0 (17.8)	8.75 (22.2)	10.0 (25.4)	12.5 (31.8)		
8.0 (20.3)	Not limited	12.0 (30.5)	Not limited	0.032	(0.81)
9.0 (22.9)	11.5 (29.2)	13.0 (33.0)	16.0 (40.6)		
12.5 (31.8)	Not limited	19.5 (49.5)	Not limited	0.042	(1.07)
14.0 (35.6)	18.0 (45.7)	21.0 (53.3)	25.0 (63.5)		
18.0 (45.7)	Not limited	27.0 (68.6)	Not limited	0.053	(1.35)
20.0 (50.8)	25.0 (63.5)	29.0 (73.7)	36.0 (91.4)		
22.0 (55.9)	Not limited	33.0 (83.8)	Not limited	0.060	(1.52)
25.0 (63.5)	31.0 (78.7)	35.0 (88.9)	43.0 (109.2)		
25.0 (63.5)	Not limited	39.0 (99.1)	Not limited	0.067	(1.70)
29.0 (73.7)	36.0 (91.4)	41.0 (104.1)	51.0 (129.5)		
33.0 (83.8)	Not limited	51.0 (129.5)	Not limited	0.080	(2.03)
38.0 (96.5)	47.0 (119.4)	54.0 (137.2)	66.0 (167.6)		
42.0 (106.7)	Not limited	64.0 (162.6)	Not limited	0.093	(2.36)
47.0 (119.4)	59.0 (149.9)	68.0 (172.7)	84.0 (213.4)		
52.0 (132.1)	Not limited	80.0 (203.2)	Not limited	0.108	(2.74)
60.0 (152.4)	74.0 (188.0)	84.0 (213.4)	103.0 (261.6)		
63.0 (160.0)	Not limited	97.0 (246.4)	Not limited	0.123	(3.12)
73.0 (185.4)	90.0 (228.6)	103.0 (261.6)	127.0 (322.6)		

^a See 6.3.3.

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

^c Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.

^d Sheet steel for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.032 inch thick.

Table 6.2
Thickness of sheet metal for electrical enclosures– aluminum, copper, or brass

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

^a See 6.3.3.

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

^c Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.

^d Sheet copper, brass, or aluminum for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.029 inch (0.74 mm) thick.

6.3.3 With reference to Tables 6.1 and 6.2, a supporting frame is a structure of angle or channel or 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 that may be applied by the enclosure surface when it is deflected. A structure that is as rigid as one built with a frame of angles or channels is considered to have equivalent reinforcing. Constructions considered to be without supporting frame include:

- a) A single sheet with single formed flanges – formed edges;
- b) A single sheet that is corrugated or ribbed;
- c) An enclosure surface loosely attached to a frame, for example, with spring clips; and

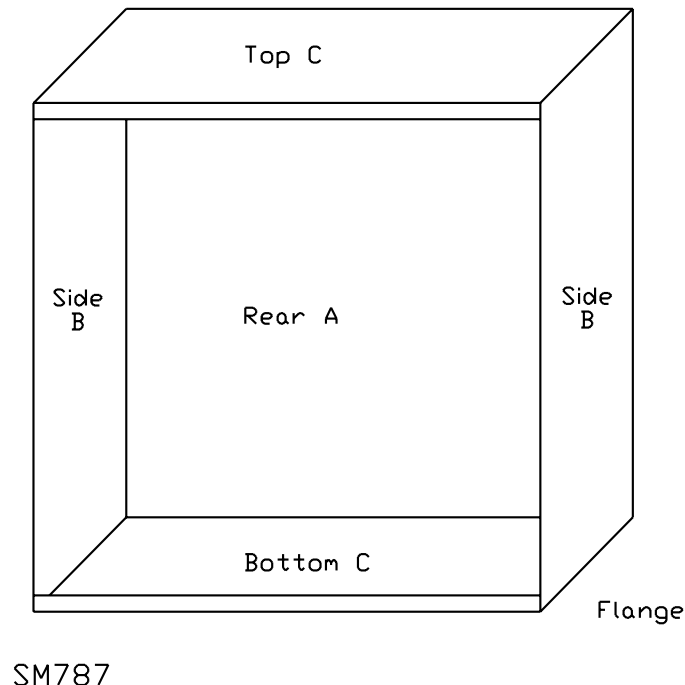
- d) An enclosure surface having an unsupported edge.

See Figure 6.6 for evaluation of supported and unsupported enclosure surfaces. This figure further defines the means of selecting the required metal thickness from either the "with supporting frame" or "without supporting frame" columns in Tables 6.1 and 6.2.

6.3.3 revised December 2, 2003

Figure 6.6
Determination of required metal thickness from Tables 6.1 and 6.2 for supported and unsupported enclosure surfaces

Figure 6.6 added December 2, 2003



NOTES:

Each enclosure surface is evaluated individually based on the length and width dimensions. For each set of surface dimensions, A, B or C, the width is the smaller dimension regardless of its orientation to other surfaces. In Tables 6.1 and 6.2, there are two sets of dimensions that correspond to a single metal thickness requirement and the following describes the applicable procedure for determining the minimum metal thickness for each surface:

1. For a supported surface, all of the table dimensions, including the "not limited" lengths, are able to be applied. The rear surface "A", top and bottom surfaces "C", are supported either by adjacent surfaces of the enclosure or by a 1/2 inch (12.7 mm) wide flange. To determine required metal thickness for supported surfaces, the width is to be measured and compared with the table value in the maximum width column that is equal to or greater than the measured width. When the corresponding length in the maximum length column is "Not limited", the minimum thickness in the far right column is to be used. When the corresponding length in the maximum length column is a numerical value, and the measured length of the side does not exceed this value, the minimum thickness from the far right column is to be used. When the measured length of the side exceeds the numerical value, the next line in the table is to be used.

2. For an unsupported surface, only the table dimensions that include a specific length requirement are applied. The dimensions with a "not limited" length do not apply. The front edge of the left and right surfaces "B", are not supported by an adjacent surface or by a flange. An edge that is rabbeted, as shown in Figure 6.1, is also evaluated as an unsupported surface. To determine the required metal thickness for unsupported surfaces, the length is to be measured and compared with the table value in the maximum length column that is not less than the measured length, ignoring the "not limited" entries. When the corresponding width in the maximum width column is not less than the measured width, the minimum thickness from the far right column is to be used. When the measured width of the surface exceeds the value in the maximum width column, the next line in the table is to be used.

6.4 Doors and covers

6.4.1 A part of an enclosure, such as a door or a cover, shall be provided with a means – such as latches, locks, interlocks, or screws – for firmly securing it in place.

Exception: A snap-on cover that complies with the requirements in Section 9 need not have additional securing means.

6.4.2 An enclosure shall be provided with a door when it gives access to a fuse or any other overload protective device that requires renewal or when it is required to be opened in connection with the normal operation of the device.

Exception: A door is not required for an enclosure:

- a) To which access is required only in the event of burnout of a current element or similar device on short circuit;*
- b) In which the only fuse enclosed is a control-circuit fuse, when the fuse and control-circuit load – other than a fixed control-circuit load, such as a pilot lamp – are within the same enclosure; or*
- c) In which a means is provided for resetting all overload-protective devices from outside the enclosure, or kits are available to provide a means for resetting all overload-protective devices from outside the enclosure and a marking is provided in accordance with Details, Section 66.*

6.4.2 revised August 22, 2000

6.4.3 Other than as noted in 6.4.5, a door provided in accordance with the requirement in 6.4.2 shall be provided with a snap latch or a captive multiturn or partial-turn fastener. Such securing means shall be located or used in multiple so as to hold the door closed over its entire length. A captive fastener shall be operable by hand or by a simple hand tool such as a screwdriver.

6.4.3 revised August 22, 2000

6.4.4 A door more than 48 inches (1.2 m) long on the hinged side shall be provided with one of the following:

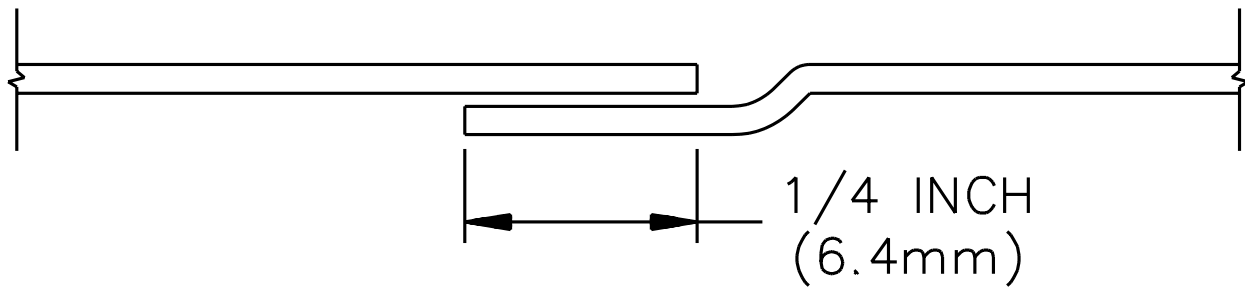
- a) A multipoint latch operated by a single knob or handle;
- b) Two or more snap latches or captive fasteners; or
- c) One knob-operated latch and one snap latch or captive fastener.

6.4.5 An enclosure that is not required to comply with 6.4.2 is able to use a door with noncaptive fasteners.

6.4.5 revised August 22, 2000

6.4.6 A door giving access to a fuse or any portion of a circuit breaker other than the operating handle shall shut closely against a 1/4-inch (6.4-mm) rabbet as illustrated in Figure 6.1 or the equivalent.

Figure 6.1
Rabbet



SA0702A

6.4.7 A cover giving access to a fuse or any portion of a circuit breaker other than the operating handle shall have flanges for the full length of the four edges. Flanges on a cover shall fit closely with the outside walls of the enclosure, and shall comply with Figure 6.2 and Table 6.3. An acceptable combination of flange and rabbet may be used.

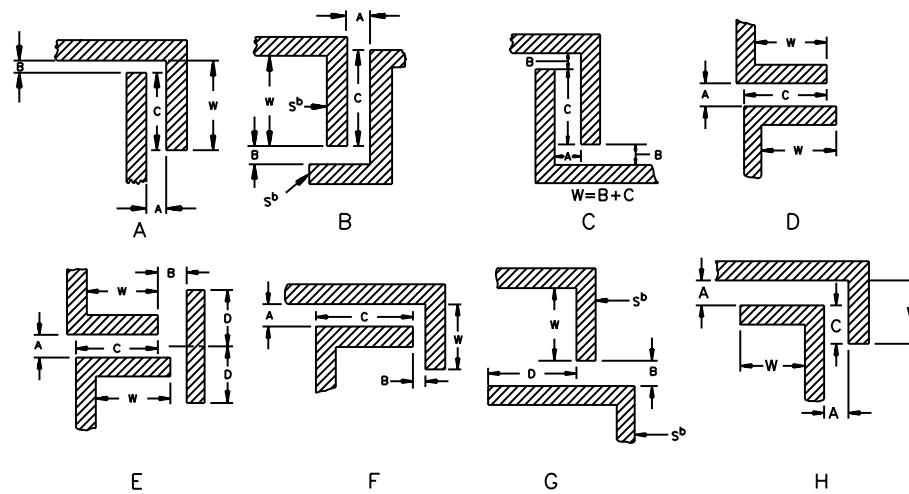
Exception No. 1: The flange width may be less than that specified if the construction complies with the Deflection Test in the Standard for Enclosures for Electrical Equipment, UL 50.

Exception No. 2: The flanges on the cover are not required to fit closely on the outside wall if a gasket suitable for the application provides the intended tight fit. The gasket shall comply with the Gasket Tests in the Standard for Electrical Equipment, UL 50.

Exception No. 3: For equipment incorporating an enclosure rated Type 1 only, the gap distance between the flanges on the cover and the outside wall are not required to comply with those specified in Table 6.3 when the equipment complies with the Short Circuit Test – General, Section 50 (and cotton is used as a fire indicator) and Accessibility of Live Parts, 6.17.

6.4.7 revised July 11, 2005

Figure 6.2
Flanged cover constructions^a



S2766A

^a See Table 6.3 for dimensions for sketches A – H.

^b The surfaces "S" may be in line with one another – not as shown.

Table 6.3
Dimensions for flanged cover constructions

Sketch – see Figure 6.2	Dimensions									
	W Minimum flange width ^a		A Maximum space between parts		B Maximum gap		C Minimum overlap		D Minimum barrier extension	
	Inches	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)
A	1/2	12.7	1/8	3.2	1/8	3.2	7/16	11.1	–	–
A	3/4	19.1	3/16	4.8	3/16	4.8	5/8	15.9	–	–
A	1	25.4	1/4	6.4	1/4	6.4	7/8	22.2	–	–
B	1/2	12.7	1/8	3.2	1/8	3.2	7/16	11.1	–	–
B	3/4	19.1	3/16	4.8	3/16	4.8	5/8	15.9	–	–
B	1	25.4	1/4	6.4	1/4	6.4	7/8	22.2	–	–
C	1/2	12.7	3/16	4.8	3/16	4.8	1/4	6.4	–	–
C	3/4	19.1	1/4	6.4	1/4	6.4	7/16	11.1	–	–
D	1/2	12.7	3/32	2.4	–	–	7/16	11.1	–	–
E	1/2	12.7	1/8	3.2	1/8	3.2	7/16	11.1	1/4	6.4
F	1/2	12.7	1/8	3.2	1/4	6.4	7/16	11.1	–	–
G ^b	1/2	12.7	–	–	1/32	0.8	–	–	1/2	12.7
H	1/4	6.4	1/8	3.2	–	–	3/16	4.8	–	–

^a Tolerance: minus 1/16 inch (1.6 mm)

^b Equipment within the enclosure must be located on the side of the barrier extension D that is opposite the gap B.

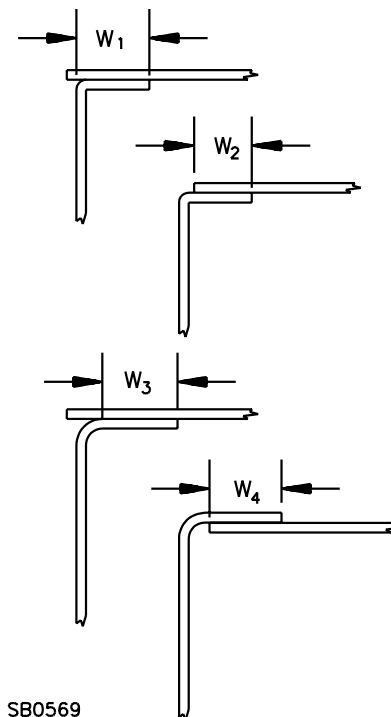
6.4.8 To determine whether a flanged cover complies with the requirement in 6.4.7 regarding width of flange, the distance between the flat portion of the cover – clear of forming radii, beads, draws, and the like – and a straight edge placed anywhere across any two flanges at any points is to be measured.

6.4.9 A construction involving a gasketed joint that provides the intended tight fit shall be investigated to determine whether it is acceptable for the application. See Section 6.15.12.

6.4.10 Figure 6.3 illustrates the method of determining the amount of overlap between a flat cover and a flanged box wall and the amount of overlap at a corner or box seam. If the radius of the flange bend is small, the flange width and overlap are considered to be W_1 or W_2 , depending upon the actual construction, and shall be at least 1/2 inch (12.7 mm). If the radius of the flange bend is excessive or if the flat sheet is on the inside of the flange, the overlap, W_3 or W_4 , is to be measured over only that portion where the two pieces of metal are actually in contact with each other, and shall be at least 1/2 inch.

6.4.11 To determine the overlap of a telescoping cover, the enclosure is to be placed on its back on a bench, with the cover in its normally closed position, and a mark is to be scribed on all walls of the box along the edge of the flange. The overlap is the measured distance between the scribe marks and the edges of the box walls, noted as W_4 in Figure 6.3. In scribing the marks, the cover is to be held in a fixed position with sufficient firmness to prevent displacement of the cover by the scribing tool, but without bending or distorting any portion of the box, cover, or other part of the enclosure.

Figure 6.3
Overlap between flat cover and box flange and at corner or box seam



SB0569

6.4.12 A flat strip used to provide a rabbet, or an angle strip fastened to the edges of a door giving access to a fuse or any portion of a circuit breaker, other than the operating handle, shall be at least 60 percent of the required thickness of the metal of the box proper, but not less than 0.042 inch (1.07 mm) if of uncoated steel, and not less than 0.058 inch (1.47 mm) thick if of nonferrous metal. It shall be secured at no fewer than two points. There shall not be more than 1-1/2 inches (38 mm) between an end of the strip and a point at which it is secured, and the distance between adjacent points at which the strip is secured shall not be more than 6 inches (152 mm).

6.4.12 revised July 11, 2005

6.5 Polymeric

6.5.1 A polymeric electrical enclosure shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C and also with the additional requirements specified in this standard. See also 6.5.5 and 6.5.6.

6.5.1 revised July 16, 1999

6.5.2 A polymeric enclosure intended for connection to a rigid conduit system shall comply with the Polymeric Enclosure Rigid Metallic Conduit Connection Tests in the Standard for Enclosures for Electrical Equipment, UL 50.

Exception: Polymeric enclosures marked or provided with instructions as noted in 11.17 is not required to be subjected to the Rigid Metallic conduit Connection Tests.

6.5.2 revised July 11, 2005

6.5.3 A polymeric part assembled to an electrical enclosure or a polymeric part of an open-type component intended to be installed through an opening in an enclosure shall be made of a material rated in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and shall comply with the following:

a) The polymeric part shall close an opening in the enclosure having an area of not more than 1.2 square inches (775 mm²) and shall be:

- 1) A pilot light lens classed 5VA, 5VB, V-0, V-1, V-2, or HB;
- 2) Rated V-0, V-1, or V-2; or
- 3) Rated HB and comply with the flammability test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

b) The polymeric part shall close an opening in the enclosure having an area of more than 1.2 square inches (775 mm²) and having no dimension greater than 12 inches (304.8 mm), shall be rated V-0, V-1, V-2, or HB, and shall comply with the flammability and impact test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: The polymeric part is not required to be subjected to the flammability test when it encloses only parts that do not pose a risk of fire, as in Section 29, and is protected from exposure to fire by an internal metal barrier or polymeric barrier that complies with the flammability test. A printed wiring board rated V-0 may serve as a polymeric barrier when the assembly complies with the flammability test.

c) The polymeric part shall close an opening in the enclosure having any dimension greater than 12 inches (304.8 mm), shall comply with the flammability and impact requirements in (b) above and also comply with requirements for the crush resistance test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.5.3 revised August 22, 2000

6.5.4 For an adhesive that secures a polymeric part closing an opening in an enclosure, the adhesive shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: A polymeric part of a component is not required to comply with this requirement when:

a) It only encloses parts which do not pose a risk of fire or electric shock; or

b) The device complies with 6.17.1 for the accessibility of live parts with the polymeric part removed and any internal parts that do pose a risk of fire or electric shock are enclosed by barriers that comply with 6.5.1 or 6.5.3, and 8.2.

6.5.4 revised July 11, 2005

6.5.5 In addition to the requirements in 6.5.1 and 6.5.3 (b) and (c), polymeric materials used for Types 3, 3R, 3RX, 3S, 3SX, 3X, 4, and 4X enclosures or polymeric materials used for closures, fastenings, or hinges for these enclosures, or as a polymeric part of an open-type component for installation on these enclosures shall comply with the Ultraviolet Light Exposure test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.5.5 revised December 2, 2003

6.5.6 In addition to the requirements in 6.5.1 and 6.5.3 (b) and (c), polymeric materials used for Types 6 and 6P enclosures or polymeric materials used for closures, fastenings, or hinges for these enclosures, or as a polymeric part of an open-type component for installation on these enclosures shall comply with the Ultraviolet Light Exposure Test and the Water Exposure and Immersion Tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.5.6 revised July 16, 1999

6.6 Bonding

6.6.1 An enclosure made of insulating material, either wholly or in part, shall have an acceptable bonding means to provide continuity of grounding between all conduit openings. The bonding means may be either completely assembled on the product or provided as separate parts for field installation. See 11.14 and 65.6.

Exception No. 1: A bonding means is not required for the enclosure of a pushbutton station or a selector switch that is intended to be connected to a single conduit. See 11.15.

Exception No. 2: A bonding means is not required to be provided with each enclosure if such means is available in the form of a kit from the manufacturer and the equipment complies with the marking requirements in 66.1.

6.6.2 The continuity of a conduit system shall be provided by metal-to-metal contact not relying on a polymeric material.

Exception: The continuity of the grounding system may rely on the integrity of the polymeric enclosure if samples have been subjected to the creep test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Overcurrent Tests shall be conducted at 200 percent of the rated current of the branch circuit-protective device.

6.6.2 revised July 11, 2005