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UL Standard for Safety
for

Class R Fuses, UL 198E

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, and figures 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that have been revised and that have a future effective date are located after the Standard and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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

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1	July 12, 1988
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1

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Standard for

Class R Fuses

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July 12, 1988

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated July 12, 1988. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

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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 published set of revision pages.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

GENERAL

1. Scope

1.1 These requirements cover Class R fuses for use in accordance with the National Electrical Code, NFPA 70.

1.2 A Class R fuse has a maximum current rating of 600 amperes, and a voltage rating of 250 or 600 volts ac.

1.3 Class R fuses are of the nonrenewable cartridge current limiting type and have an interrupting rating of 200,000 rms symmetrical amperes, with peak let-through currents and total clearing amperes-squared-seconds specified for the individual case sizes.

1.4 These fuses are intended for use with fuseholders which will properly receive Class R fuses, but will not receive fuses of any other type. Class R fuses may also be used with fuseholders which will properly receive Class H fuses.

1.5 Class R fuses are divided into two subclasses, depending upon the peak let-through current and total amperes-squared-seconds characteristics. These subclasses are identified by the designation RK1 or RK5 and are physically interchangeable.

2. Glossary

2.1 **CASE SIZE** — Fuses of all ratings for which the size of the cartridge is the same, for example fuses rated in the range of 31–60 amperes, 250 volts are 60 ampere case size and fuses rated in the range of 61–100 amperes, 600 volts are 100 ampere case size.

2.2 **CLEARING TIME** — The time elapsing from the beginning of an overcurrent condition to the final circuit interruption. The clearing time is equal to the sum of the melting time and the arcing time.

2.3 **CURRENT-LIMITING FUSE** — A fuse that properly interrupts all available currents within its interrupting rating and, within its current-limiting range, limits the clearing time at rated voltage to an interval equal to or less than the first major or symmetrical current loop duration and limits peak let-through current to a value less than the peak current that would be possible with the fuse replaced by a solid conductor of the same impedance.

2.4 **CURRENT-LIMITING RANGE** — That range of rms symmetrical available currents that is equal to and less than the interrupting rating in which the total clearing time at rated voltage and frequency is less than 1/2 cycle.

2.5 **INTERRUPTING RATING** — The rating specifying the highest rms symmetrical alternating current that the fuse is required to interrupt under the conditions of these requirements.

2.6 **I^2t (AMPERES-SQUARED-SECONDS)** — An expression of the energy available as a result of current flow. The term is usually applied during the melting, arcing, or total clearing time of the fuse under which, in the latter instance, it is often designated as Clearing I^2t .

2.7 **MAXIMUM ENERGY** — The test condition under which, in a specified maximum time (1/2 cycle), the maximum amount of heat possible is generated in the fuse before clearing.

2.8 **MELTING TIME** — The time between the initiation of a current large enough to cause the current-responsive element to melt and the instant when arcing starts.

2.9 **NORMAL FREQUENCY RECOVERY VOLTAGE** — The normal frequency rms voltage impressed upon the fuse after the circuit has been interrupted and after high-frequency transients have subsided.

2.10 PEAK LET-THROUGH CURRENT (I_p) — The maximum instantaneous current through the fuse during the total clearing time.

2.11 RATING TESTS — Current-Carrying-Capacity Test, Section 7, Temperature Test, Section 8, and Clearing Time-Current Test, Section 9.

2.12 RECOVERY VOLTAGE — The voltage impressed upon the fuse after a circuit has been interrupted.

2.13 THRESHOLD CURRENT — The rms symmetrical available current at the threshold of the current-limiting range, where melting of the current-responsive element has occurred at approximately 90 degrees on the symmetrical current wave and total clearing time is less than 1/2 cycle under specified conditions.

2.14 THRESHOLD RATIO — The ratio obtained by dividing the threshold current by the continuous current rating of the fuse.

3. Units of Measurement

3.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

4. 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.

CONSTRUCTION

5. General

5.1 Iron or steel, plated or unplated, shall not be used for parts that are depended upon to carry current.

5.2 A connection between the fusible element and a terminal of a fuse shall provide positive and permanent electrical contact. A connection shall be soldered, brazed, or welded, or shall otherwise be made equivalently secure.

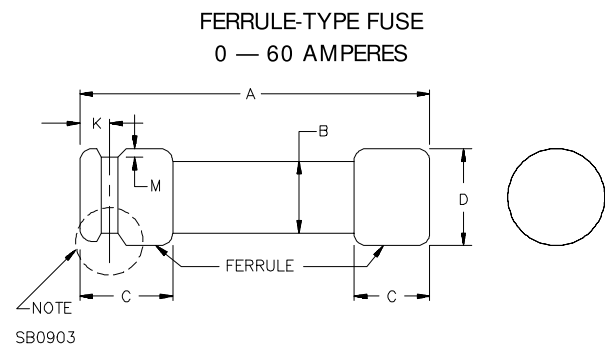
5.3 The tube shall be of ceramic, melamine-impregnated glass fiber, or the equivalent. Other materials may be used if found acceptable for the application, as determined by investigation.

5.4 Among the factors taken into consideration when a tube is being judged for acceptability are its physical strength, (2) resistance to impact, (3) moisture-absorptive properties, (4) combustibility, and (5) resistance to distortion at temperatures to which it may be subjected under conditions of normal and abnormal use. These factors are considered with respect to thermal aging.

5.5 An adhesive employed in a fuse shall be acceptable for the application and shall function as intended. See paragraphs 5.7—5.10.

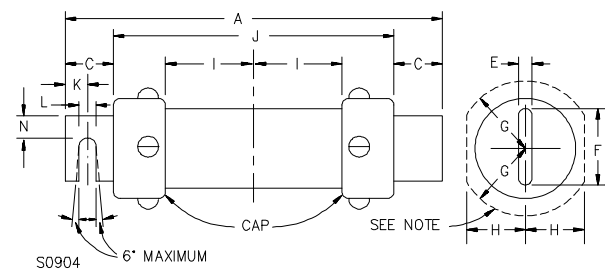
5.6 A ferrule shall be of brass or copper and shall be circular in cross section, as shown in Figure 5.1.

FIGURE 5.1
CLASS R CARTRIDGE FUSES



Note — See Figure 5.2 for rejection groove details.

KNIFE-BLADE-TYPE FUSE
61 — 600 AMPERES



Note — The dash line represents the limit of the maximum projection of a screw, rivet head, or the like. It becomes a circle for a fuse rated more than 200 amperes.

5.7 The ferrules of a fuse shall be aligned so the fuse passes through a cylindrical gauging tube having a length not less than that of the fuse and an inside diameter as indicated in Table 5.1.

TABLE 5.1
DIAMETERS OF GAUGING TUBES

Fuse Rating, Amperes	Inside Diameter of Gauging Tube, Inches (mm)			
	250-Volt Fuses		600-Volt Fuses	
0 — 31	0.580	(14.73)	0.830	(21.08)
31 — 60	0.830	(21.08)	1.080	(27.43)

Table 5.1 revised July 13, 1988

5.8 The blades of a fuse shall be of copper or brass and shall be in substantial alignment (see Figure 5.1).

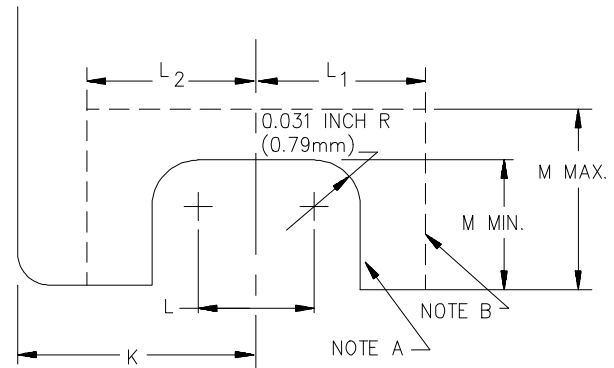
5.9 Alignment of the blades shall be provided by means other than friction between surfaces.

Exception: A press-fitted assembly of materials not subject to shrinkage or warping due to heat or moisture is considered acceptable for maintaining blade alignment.

5.10 A cap shall be of metal of a thickness that provides acceptable physical strength and, if depended upon to carry current, shall be of brass or copper. Caps, assembly rings, washers, and the like, of iron or steel shall be protected against corrosion.

5.11 The dimensions of a Class R fuse shall be in accordance with Figures 5.1 and 5.2 and Tables 5.2 and 5.3. The rejection slot or groove shall be incorporated in only one end of the fuse.

FIGURE 5.2
CLASS R FUSES — FERRULE TYPE REJECTION
GROOVE DETAILS



SB1275

Note A — Solid line indicates location, shape, and dimensions for minimum rejection groove.

Note B — Dashed line indicates location, shape, and dimensions for maximum rejection groove.

5.12 Solder or any other projection on the end of a ferrule-type fuse shall not cause the total length of fuse over such a projection to exceed the maximum length given in Column A of Table 5.2.

5.13 No part of a knife-blade type fuse shall extend farther from the axis of the fuse than the distance given in Column G of Table 5.3.

TABLE 5.2
DIMENSIONS OF FERRULE-TYPE CLASS R FUSES IN INCHES (MM)

Rating		Overall Length of Fuse ^a	Maximum Outside Diameter of Tube	Minimum Length of Ferrule	Outside Diameter of Ferrule ^b	Distance of Rejection Feature From End ^c	Minimum Width of Rejection Feature ^d	Minimum- Maximum Depth of Rejection Feature	Maximum Width Toward End	Maximum Width Toward Body
Volts	Amperes	A	B	C	D	K	L	M	L	L ₁
250	0 — 30	2.000 (50.80)	0.531 (13.49)	0.500 (12.70)	0.562 (14.27)	0.156 (3.96)	0.070 (1.78)	0.085 — 0.130 (2.16 — 3.30)	0.115 (2.92)	0.150 (3.81)
	31 — 60	3.000 (76.20)	0.781 (19.84)	0.625 (15.88)	0.812 (20.62)	0.188 (4.78)	0.086 (2.18)	0.085 — 0.130 (2.16 — 3.30)	0.123 (3.12)	0.170 (4.32)
600	0 — 30	5.000 (127.00)	0.781 (19.84)	0.500 (12.70)	0.812 (20.62)	0.188 (4.78)	0.086 (2.18)	0.085 — 0.130 (2.16 — 3.30)	0.123 (3.12)	0.170 (4.32)
	31 — 60	5.500 (139.70)	0.031 (26.19)	0.625 (15.88)	1.062 (26.97)	0.250 (6.35)	0.086 (2.18)	0.085 — 0.130 (2.16 — 3.30)	0.154 (3.91)	0.180 (4.57)

^aTolerances: ± 0.031 inch (± 0.79 mm).

^bTolerance: ± 0.008 inch (± 0.20 mm). To provide proper contact, the diameter of rejection ferrule end shall be equal to or not more than 0.050 inch (1.27 mm) smaller than actual diameter of main contact area for any fuse and no part of rejection ferrule end shall protrude beyond the diameter of the main part of the ferrule.

^cTolerance: plus 0.008, minus 0.016 inch (plus 0.20, minus 0.41 mm).

^dDistance between centers of 0.031 inch (0.79 mm) radius fillets. Shape of rejection groove is not specified but shall be completely within solid and dashed lines regardless of shape.

TABLE 5.3
DIMENSIONS OF BLADE TYPE CLASS R FUSES IN INCHES (MM)

Rating		Overall Length of Fuse ^a	Minimum Length of Blade ^b	Thickness of Blade ^c	Width of Blade ^d	Maximum Dimensions Over Projections		Minimum Distance From Mid-point of Fuse to Nearest Live Part	Minimum-Maximum Overall Length of Cylindrical Body ^e	Distance of Rejection Feature From End ^f	Width of Rejection Feature ^g	Web Width of Blade at Rejection Feature ^h
Volts	Amperes					Measured Parallel to Blade	Measured at Right Angles to Blade					
		A	C	E	F	G	H	I	J	K	L	N
250	61 — 100	5.875 (149.22)	1.000 (25.40)	0.125 (3.18)	0.750 (19.05)	0.656 (16.66)	0.594 (15.09)	1.031 (26.19)	3.375 — 3.781 (85.72 — 96.04)	0.500 (12.70)	0.281 (7.14)	0.250 (6.35)
	101 — 200	7.125 (180.98)	1.375 (34.92)	0.188 (4.78)	1.125 (28.58)	0.938 (23.83)	0.844 (21.44)	1.188 (30.18)	4.125 — 4.281 (104.78 — 108.74)	0.688 (17.48)	0.281 (7.14)	0.438 (11.13)
	201 — 400	8.625 (219.08)	1.875 (47.62)	0.250 (6.35)	1.625 (41.28)	1.203 (30.56)	1.203 (30.56)	1.188 (30.18)	4.625 — 4.813 (117.48 — 122.25)	0.938 (23.83)	0.406 (10.31)	0.625 (15.88)
	401 — 600	10.375 (263.52)	2.250 (57.15)	0.250 (6.35)	2.000 (50.80)	1.453 (36.91)	1.453 (36.91)	1.531 (38.89)	5.188 — 5.813 (131.78 — 147.65)	1.125 (28.58)	0.531 (13.49)	0.750 (19.05)
600	61 — 100	7.875 (200.02)	1.000 (25.40)	0.125 (3.18)	0.750 (19.05)	0.781 (19.84)	0.719 (18.26)	1.750 (44.45)	5.375 — 5.781 (136.52 — 146.84)	0.500 (12.70)	0.281 (7.14)	0.250 (6.35)
	101 — 200	9.625 (244.48)	1.375 (34.92)	0.188 (4.78)	1.125 (28.58)	1.062 (26.97)	0.984 (24.99)	2.250 (57.15)	6.125 — 6.781 (155.58 — 172.24)	0.688 (17.48)	0.281 (7.14)	0.438 (11.13)
	201 — 400	11.625 (295.28)	1.875 (47.62)	0.250 (6.35)	1.625 (41.28)	1.453 (36.91)	1.453 (36.91)	2.500 (63.50)	7.125 — 7.831 (180.98 — 198.90)	0.938 (23.83)	0.406 (10.31)	0.625 (15.88)
	401 — 600	13.375 (339.72)	2.250 (57.15)	0.250 (6.35)	2.000 (50.80)	1.719 (43.66)	1.719 (43.66)	2.688 (68.28)	8.188 — 8.844 (207.98 — 224.64)	1.125 (28.58)	0.531 (13.49)	0.750 (19.05)

^aTolerances: 61 — 200 amperes, ± 0.062 inch (± 1.57 mm); 201 — 600 amperes, ± 0.094 inch (± 2.39 mm).

^bOne blade shall not be more than 0.062 inch (1.57 mm) longer than the other blade.

^cTolerance: ± 0.003 inch (± 0.08 mm).

^dTolerance: ± 0.035 inch (± 0.89 mm).

^eThe length of the cylindrical body may be less than the indicated value if other acceptable interference means such as pins through the blades or collars are provided to prevent mounting the fuse in a fuseholder that will accommodate a fuse rated in the next lower bracket of current ratings.

^fTolerance: ± 0.008 inch (± 0.20 mm).

^gTolerance: minus 0.005, plus 0.025 inch (minus 0.13, plus 0.64 mm). Dimension is diameter of slot at semicircle. Maximum rounding of corner at end of slot 0.125 inch (3.18 mm) radius.

^hTolerance: ± 0.031 inch (± 0.79 mm).

PERFORMANCE

6. General

6.1 Samples of fuses are to be subjected to carrying capacity, temperature, clearing-time-current, 200 percent clearing at rated voltage, interrupting ability, maximum fuse energy, let-through measurement, intermediate interrupting ability, maximum threshold rating, and low interrupting ability tests.

6.2 All power factors are lagging, with circuit resistances and reactances in series connection.

6.3 Tests of fuses are performed on groups of samples, referred to herein as sets. Table 6.1 gives the number of samples to be subjected to each test in accordance with the rating of the fuses.

6.4 One set of fuses of each of the ratings 30, 60, 100, 200, 400, and 600 amperes at each voltage rating (or whichever of these ratings are being submitted) are to be made available by the manufacturer for the rating tests, and sufficient fuses of each rating are to be available for the interrupting tests. (See Table 6.1.)

6.5 Table 6.1 is based on the assumption that the same internal features, such as link material and shape, are constant for any fuse case size. If the internal features, such as link material, change at some intermediate rating in a particular fuse case size, this fact is to be taken into account during selection of test samples, and samples are to be selected so that constructions involving each different type of material or construction, are subjected to the complete test program outlined in paragraph 6.1.

6.6 A set of fuses of a given rating is to be subjected to the rating tests specified. The interrupting tests are to be performed on separate samples of that rating. If the overall results of the rating tests and interrupting tests on the samples of one of the ratings enumerated in paragraph 6.4 are acceptable, all fuses of the case size represented by those samples are considered to comply with the requirements. (See paragraph 6.5.)

6.7 To determine whether an adhesive complies with the requirement in paragraph 5.5, samples of the fuse are to be subjected to appropriate interrupting ability, low interrupting ability, and 200 percent clearing at rated voltage tests. Except as noted in paragraph 6.10, before being tested, samples are to be conditioned in an oven at the temperature and time described in paragraph 6.8 and the other samples are to be conditioned for a minimum of 5 days in a humidity cabinet having a relative humidity of 93 ± 2 percent at $32.0 \pm 2.0^\circ\text{C}$ ($89.6 \pm 3.6^\circ\text{F}$).

6.8 The oven conditioning described in paragraph 6.7 is to be conducted for 1000 hours. The oven temperature is to be taken from the intersection of a selected temperature index line in Figure 6.1 with the 1000 hour line, where the temperature index T is, at the manufacturer's option, either (1) the maximum observed operating temperature of the adhesive, or (2) the maximum acceptable operating temperature of any part in contact with the adhesive. Intermediate temperature indices may be interpolated. The maximum observed operating temperature is that attained when the fuse is carrying 110 percent of rated current, and while in a 25°C (77°F) ambient. Measurement may be made in ambients of $18\text{--}32^\circ\text{C}$ ($64\text{--}90^\circ\text{F}$), and the reading corrected to 25°C . The maximum acceptable operating temperature is the sum of two values: (1) the rise permitted in the temperature test, and (2) 25°C .

Exception: On the same selected temperature index line in Figure 6.1, a shorter or longer time at the corresponding higher or lower temperature, respectively, may be employed if agreeable to all concerned, providing that the time is not less than 300 hours.

6.9 After conditioning, fuses are to be brought to and tested at room temperature to determine the performance.

6.10 Conditioning tests on an adhesive may be omitted if the fuse performs acceptably during the interrupting ability, low interrupting ability, and 200 percent clearing at rated voltage tests, with the adhesive omitted.

TABLE 6.1
CLASS R FUSES — REQUIRED TEST SAMPLES

Fuse Rating, Amperes	Rating Tests ^a				200 Percent Clearing at Rated Voltage Test ^b	Interrupting Ability and Let-Through Measurement Tests ^d								Total Fuses Rating Test Plus Others ^e
	110 Percent Current and Temperature	Clearing Time — Current		Time Delay Test at 500 Percent ^c		High Interrupting Ability	Intermediate Interrupting				Low Interrupting 10 kA ^g	Maximum Fuse Energy ^f	Threshold Ratio	
		135 Percent	200 Percent				100 kA	50 kA	25 kA					
0 — 30	3	3	2	2	1	1	1	1	1	5	1	1	19	
31 — 60	3	3	2	2	1	1	1	1	1	4	1	1	18	
61 — 100	3	3	2	1	1	1	1	1	1	3	1	1	16	
101 — 200	3	2	2	1	1	1	1	1	1	2	1	1	14	
201 — 400	3	2	2	1	1	1	1	1	1	2	1	1	14	
401 — 600	3	2	2	1	1	1	1	1	1	2	1	1	14	

^aIf the manufacturer so elects, fuses that successfully complete the temperature and 110-percent current tests may be used for the 135-percent- or 200-percent-current tests, in which case the temperature of such fuses shall not be higher than that of the ambient air when the 135-percent- or 200-percent-current test is started.

^bThis test may be combined with the 200-percent current test if conditions of both tests are met.

^cFor 30 and 60 ampere case sizes, the two samples required are to consist of one sample of the maximum rating and one sample of the minimum rating for that case size, for example 30 and 8 ampere or 60 and 35 ampere ratings. See paragraph 6.5.

^dAssumes same sample used for let-through measurement and interrupting ability at 200 kiloamperes, 100 kiloamperes, 25 kiloamperes, Maximum Energy, and Maximum Threshold Ratio. Samples and test circuits are to meet the conditions of each test.

^eAssumes same sample used for temperature and clearing-time-current tests.

^fSee exception to paragraph 10.22.

^gFor paper tube fuses, three sets of samples are needed. See paragraph 5.3.