

FEDERAL SPECIFICATION

FUSES, CARTRIDGE, HIGH-INTERRUPTING CAPACITY

This specification is approved by the Assistant Administrator, Office of Personal Property, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the general requirements for current-limiting and noncurrent-limiting, nonrenewable, cartridge fuses with interrupting capacity ratings of 100,000 or 200,000 rms symmetrical amperes (see 3.1 and 6.1).

1.2 Classification. Fuses shall be of the following classes as specified (see 3.1):

- Class G - Current-limiting, 300 volts, 0-60 amperes
- Class J - Current-limiting, 600 volts, 0-600 amperes
- Class K9 - Noncurrent-limiting, 250 and 600 volts, 0-600 amperes
- Class K5 - Noncurrent-limiting, 250 and 600 volts, 0-600 amperes
- Class K1 - Noncurrent-limiting, 250 and 600 volts, 0-600 amperes
- Class RK5 - Current-limiting, 250 and 600 volts, 0-600 amperes
- Class RK1 - Current-limiting, 250 and 600 volts, 0-600 amperes
- Class L - Current-limiting, 600 volts, 601-6000 amperes

2. APPLICABLE DOCUMENTS

2.1 Government publications. The issues of the following documents, in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Specifications

- J-C-30 - Cable and Wire, Electrical (Power, Fixed Installation).
- L-P-378 - Plastic Sheet and Strip, Thin Gauge, Polyolefin.
- L-P-513 - Plastic Sheet and Insulation Sheet, Electrical (Laminated, Thermosetting, Paper-Base, Phenolic-Resin).
- W-F-870/GEN - Fuseholders and Fuseclips (For Plug and Enclosed Cartridge Fuses).
- NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial).
- QQ-B-613 - Brass, Leaded and Nonleaded; Flat Products (Plate, Bar, Sheet, and Strip).
- QQ-B-626 - Brass, Leaded and Nonleaded: Rod, Shapes, Forgings, and Flat Products with Finished Edges (Bar and Strip).
- QQ-B-750 - Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections.
- QQ-C-576 - Copper Flat Products with Slit, Slit and Edge-Rolled, Sheared, Sawed, or Machined Edges, (Plate, Bar, Sheet, and Strip).
- QQ-S-781 - Strapping, Steel, and Seals.
- PPP-B-566 - Boxes, Folding, Paperboard.
- PPP-B-585 - Boxes, Wood, Wirebound.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 - Boxes, Shipping, Fiberboard.
- PPP-B-665 - Boxes: Paperboard, Metal Edged and Components.
- PPP-B-676 - Boxes, Setup.

Federal Standards

- Fed. Std. No. 123 - Marking for Shipment (Civil Agencies).

(Activities outside the Federal Government may obtain copies of Federal specifications, standards, and commercial item descriptions as outlined under General Information in the Index of Federal Specifications, Standards, and Commercial Item Descriptions. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification, and other Federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from General Services Administration Business Service Centers in Boston, MA; New York, NY; Washington, DC; Atlanta, GA; Chicago, IL; Kansas City, MO; Fort Worth, TX; Denver, CO; San Francisco, CA; Los Angeles, CA; and Seattle, WA.

(Federal Government activities may obtain copies of Federal standardization documents and the Index of Federal Specifications, Standards, and Commercial Item Descriptions from established distribution points in their agencies.)

Military Specifications

MIL-I-10	-	Insulating Materials, Electrical, Ceramic, Class L.
MIL-P-79	-	Plastic Rods and Tubes, Thermosetting, Laminated.
MIL-P-116	-	Preservation, Methods of.
MIL-F-1148	-	Fibre, Vulcanized, Electrical and Mechanical Grades.
MIL-P-15037	-	Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
MIL-I-16923	-	Insulating Compound, Electrical, Embedding.
MIL-C-21768	-	Copper Alloy Numbers 210 (Gilding, 95%) and 220 (Commercial Bronze, 90%) Sheet and Strip.

Military Standards

MIL-STD-105	-	Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	-	Marking for Shipment and Storage.
MIL-STD-147	-	Palletized Unit Loads.
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-1188	-	Commercial Packaging of Supplies and Equipment.
MIL-STD-45662	-	Calibration Systems Requirements.

(Copies of specifications and standards required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

Underwriters Laboratories Inc. (UL) Standards

UL198C	-	Standard for High-Interrupting Capacity Fuses, Current-Limiting Types.
UL198D	-	Standard for High-Interrupting Capacity Class K Fuses.
UL198E	-	Standard for Class R Fuses.

(Application for copies should be addressed to the Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

American National Standard

ANSI C97.1	-	American National Standard for Low-Voltage Cartridge Fuses, 600 Volts or Less.
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(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between this specification and the specification sheet, the latter shall govern.

3.1.1 Fuse ratings not listed in specification sheets. This specification is applicable to other fuse ratings, provided the desired ratings fall within the maximum and minimum current and voltage ratings specified in the applicable specification sheet. Such fuses shall be considered nonstandard items, and no Government part number will be assigned.

3.2 Qualification. Fuses furnished under this specification shall be products which are qualified for listing on the applicable qualified products list (see 4.5 and 6.3).

3.3 Terms and definitions. The definitions of all terms used herein shall be as specified in ULI98C, ULI98D, ULI98E, and ANSI C97.1.

3.4 Material. The material for each part shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the fuses to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.4.1 Restricted material. Flammable or explosive material, or material which can produce toxic or suffocating fumes when the fuses are in service shall not be used in construction of the fuses.

3.4.2 Enclosure. Fuses shall have a suitable enclosure which shall prevent lint and dust collecting near the fusible link and thus becoming ignited during overload and interrupting capacity rating tests.

3.4.3 Case or body. The tube shall be of hard-fiber, ceramic, or melamine-impregnated glass fiber as specified (see 3.1). Other material may be used provided the fuse is capable of meeting the requirements of 3.10.

3.4.3.1 Fiber. Fiber shall conform to grade CH, form T, of MIL-F-1148.

3.4.3.2 Plastic. Unless otherwise specified (see 3.1), any plastic insulation may be used, except that cotton-base or cotton- or cellulose-filled molding material shall not be used. Laminated plastic sheets, type PBE-P or GME, conforming to L-P-513 and MIL-P-15037, respectively, and laminated tubes, type PBE, PBG, or form Tr, conforming to MIL-P-79 shall be acceptable.

3.4.3.3 Ceramic. Ceramic insulation shall be grade L311 or higher grade, in accordance with MIL-I-10.

3.4.3.4 Epoxy. Epoxy encapsulant compound shall conform to MIL-I-16923.

3.4.3.5 Adhesives. An adhesive employed in a fuse shall adequately and reliably secure together the parts that it is intended to secure (see 3.10).

3.4.3.6 Current-carrying parts (except fuse element). Current-carrying parts shall be of brass, copper, phosphor bronze, or copper alloy conforming to QQ-B-613 or QQ-B-626, QQ-C-576, QQ-B-750, and MIL-C-2176B, respectively.

3.4.3.7 Noncurrent-carrying parts. All metal noncurrent-carrying parts shall be of corrosion resistant material or of material adequately protected against corrosion.

3.5 Design and construction. Fuses shall be of the design, construction, and physical dimensions specified (see 3.1).

3.5.1 Mounting. Unless otherwise specified (see 3.1), the fuse shall be designed for use in fuseholders in accordance with W-F-870/GEN and permit convenient insertion and removal from fuseholders without the use of special tools.

3.5.2 Terminals. Terminals shall be secured to the fuse body so that they will not loosen. The fuse element shall be attached to the terminals so that there will be no danger of breaking the fuse element or connections when installing the fuse. Fuses with knife blade terminals shall be aligned so that their planes are within 4 degrees of each other. The alignment shall be insured by means other than friction.

3.5.3 Ferrule alignment. Fuses with ferrule terminals shall pass through a tubular gage having a length not less than that of the fuse. The tubular gage shall have an internal diameter 0.005 inch greater than the maximum ferrule diameter for fuse lengths up to and including 1-3/4 inches. For fuse lengths greater than 1-3/4 inches, the tubular gage shall have an internal diameter 0.010 inch greater than the maximum ferrule diameter.

3.6 Terminal strength. When tested as specified in 4.7.2, fuse terminals shall not loosen or become damaged.

3.7 Current carrying capacity. When tested as specified in 4.7.3, fuses shall carry the specified percentage of current indefinitely (see 3.1). The temperature of the body shall at no point rise more than the amount specified (see 3.1).

3.8 Watts loss (when specified, see 3.1). When fuses are tested as specified in 4.7.4, the watts loss shall be as specified (see 3.1).

3.9 Overload interrupt. When tested as specified in 4.7.5, fuses shall open the circuit within the time specified (see 3.1) without causing the case or body to char, fracture, or otherwise sustain physical damage. Time delay or dual element fuses shall not open the circuit faster than specified (see 3.1).

3.9.1 Opening at rated voltage. When tested as specified in 4.7.5.1, classes G, J, K, and R fuses shall open the circuit without causing the case or body to char, fracture, or otherwise sustain physical damage.

3.10 Interrupting capacity rating. When fuses are tested as specified in 4.7.6, the interrupting capacity shall be not less than specified (see 3.1). The fuse shall remain intact and permanently open the circuit and shall not ignite cotton, emit molten solder, or permit movement or deformation of either or both end-caps.

3.11 Threshold ratio (when specified, see 3.1). When tested as specified in 4.7.7, the fuses shall clear the circuit in the first half cycle after the circuit is closed. The maximum threshold ratio for the fuse shall be as specified (see 3.1).

3.12 Peak let-thru current. When fuses are tested as specified in 4.7.8, the peak let-thru current shall not exceed the limit specified (see 3.1).

3.13 Maximum clearing I²T. When fuses are tested as specified in 4.7.9, the amount of ampere-squared seconds passed by the fuse during melting, arcing, and clearing shall not exceed the value specified (see 3.1).

3.14 Marking. Fuses shall be marked in a manner which will be plainly visible after the fuse has been installed in a standard fuseholder. All markings shall be legible. The marking shall include the following:

- a. Classes G, J, K1, K5, K9, RK1, RK5, or L as specified (see 3.1).
- b. Manufacturer's name, code, or trademark.
- c. Current rating in amperes.
- d. Classes G, J, R, and L fuses shall be identified as "Current Limiting". (Classes K1, K5, and K9 shall not be identified as current limiting.)
- e. The interrupting rating (see 3.1).
- f. Time delay fuses (see 3.1) shall be identified with a letter "D" or the words "Time Delay".

3.14.1 Government part number. The Government part number (see 3.1) may be marked on the item at the option of the manufacturer.

3.14.2 Underwriters Listing (UL) mark. Fuses which conform to UL198C, UL198D, or UL198E (see 4.5b.), shall have the UL mark on each fuse.

3.15 Workmanship. Fuses shall be manufactured and processed in such a manner as to be uniform in quality and shall be free from loose terminals, cracked or displaced parts, sharp edges, burrs, and other defects that will affect life, serviceability, or appearance.

3.15.1 Soldering. Soldering shall be such as to minimize the spattering of solder and flux onto surrounding surfaces. Only noncorrosive fluxes shall be used, unless it can be shown that all corrosive products have been satisfactorily removed or neutralized after soldering. All soldered connections shall be of such character and quality that the bonding between the soldered items may be determined by visual examination. There shall be no evidence of "cold soldering", and the use of excessive amounts of solder will not be permitted.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Test equipment and inspection facilities. The manufacturer shall provide the required test equipment and facilities for conducting all tests which are to be made at the factory. Meters shall be of 1-percent accuracy and regularly calibrated. Compliance with the requirements of MIL-STD-45662 shall be acceptable.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

- a. Qualification inspection (see 4.5).
- b. Quality conformance inspection (see 4.6).

4.3 Inspection of materials and components. In accordance with 4.1, the contractor is responsible for insuring that materials and components used were manufactured, tested, and inspected in accordance with the requirements of this specification and of referenced subsidiary specifications and standards to the extent specified, or if none, in accordance with this specification (see 3.4).

4.4 Inspection conditions. All inspections, examinations, and tests shall be performed in accordance with the applicable conditions specified in UL198C for classes G, J, and L fuses; UL198D for classes K1, K5, and K9 fuses; and UL198E for classes RK1 and RK5 fuses.

4.5 Qualification inspection. Qualification shall be obtained by either of the following:

- a. By testing the fuses in accordance with 4.5.1, qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.
- b. By having UL listing in accordance with UL198C, UL198D, or UL198E, manufacturers electing this option shall submit a letter of certification to the qualifying activity listing the UL file number, the Government part number, and the manufacturer's part number for each fuse rating for which qualification is desired. The manufacturer shall also certify that he will notify the qualifying activity of any problem which threatens loss of UL listing within 30 days after recognition of the problem.

4.5.1 Inspection routine (applicable to 4.5a. only). Fuses shall be subjected to the inspections specified in table I, in the order shown. Sample size, character of failures, and number of failures permitted shall be as specified in UL198C for classes G, J, and L fuses; as specified in UL198D for classes K1, K5, and K9 fuses; and as specified in UL198E for RK1 and RK5 fuses.

TABLE I. Qualification inspection.

Inspection	Applicability (class)	Requirement paragraph	Method paragraph
Visual and mechanical examination - - - - -	G, J, K1, K5, K9, RK1, RK5, L	3.1 thru 3.5.3, 3.14, and 3.15	4.7.1
Terminal strength - - -	G, J, K1, K5, K9, RK1, RK5, L	3.6	4.7.2
Current carrying capacity - - - - -	G, J, K1, K5, K9, RK1, RK5, L	3.7	4.7.3
Watts loss - - - - -	G	3.8	4.7.4
Overload interrupt		3.9	4.7.5
135 percent - - - - -	G, J, K1, K5, K9, RK1, RK5		
150 percent - - - - -	L		
200 percent - - - - -	G, J, K1, K5, K9, RK1, RK5		
500 percent - - - - -	K1, K5, K9, RK1, RK5		
Opening at rated voltage - - - - -	G, J, K1, K5, K9, RK1, RK5	3.9.1	4.7.5.1
Interrupting capacity rating		3.10	4.7.6
Interrupting ability -	G, J, K1, K5, K9, RK1, RK5, L		
Maximum energy - - -	G, J, K1, K5, K9, RK1, RK5, L		
Intermediate interrupting ability - - - - -	G, K1, K5, K9, RK1, RK5		
Low interrupting ability	G, K1, K5, K9, RK1, RK5		
Threshold ratio - - -	G, J, RK1, RK5, L	3.11	4.7.7
Peak let-thru current -	G, J, K1, K5, K9, RK1, RK5, L	3.12	4.7.8
Maximum clearing I ² T - -	G, J, K1, K5, K9, RK1, RK5, L	3.13	4.7.9

4.5.2 Retention of qualification. To retain qualification, the contractor shall forward a report at 12-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

- a. A summary of the results of tests performed for inspection of product for delivery, groups A and B, indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.
- b. A summary of the results of tests performed for qualification verification inspection, group C, including the number and mode of failures. The summary shall include results of all qualification verification inspection tests performed and completed during the 12-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list. Failure to submit the report within 30 days after the end of each 12-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 12-month period that the inspection data indicates failure of the qualified product to meet the requirements of this specification. In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative product of each class, voltage rating, and current rating to testing in accordance with the qualification inspection requirements.

- c. Those contractors that used the UL Listing Mark to obtain qualification shall submit certification that the qualified fuses retain the UL Listing Mark, at 12-month intervals, to the qualifying activity. The initial reporting date shall be established by the qualifying activity. Failure to submit the certification within 30 days after the end of each 12-month period may result in loss of qualification for the product. Contractors shall notify the qualifying activity immediately of inspection data that indicates failure of the product to meet the requirements of UL198C, UL198D, or U1198E.

4.6 Quality conformance inspection. Quality conformance inspection shall consist of groups A, B, and C inspections as specified herein, for fuses which qualified in accordance with 4.5a. For fuses which qualified in accordance with 4.5b the UL Listing Mark shall be evidence of compliance.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections.

4.6.1.1 Inspection lot. An inspection lot shall consist of all fuses of the same class and current rating produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table II.

TABLE II. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	AQL (percent defective)	
			Major	Minor
Visual and mechanical examination- - - - -	3.1 thru 3.5.3, 3.14, and 3.15	4.7.1	1.0	4.0
Terminal strength- - - - -	3.6	4.7.2	1.0	---

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality level (AQL) shall be as specified in table II. Major and minor defects shall be as defined in MIL-STD-105.

4.6.1.2.1.1 Classification of defects. The classification of defects for group A inspection shall be as follows:

Categories	Defects
Major	
1	Material not as specified (see 3.4).
2	Terminal mounting not as specified (see 3.5.1).
3	Fuses will not pass through gage as specified (see 3.5.3).
4	Terminal alignment not as specified (see 3.5.2 and 3.5.3).
5	Terminal strength not as specified (see 3.6).
6	Broken insulating material (see 3.4.3).
7	Marking - Incorrect class designation (see 3.14).
Minor	
8	Illegible or improperly located markings (see 3.14).
9	Minor cuts, scratches, burrs and nicks not impairing function.
10	Dimensions out of tolerance not affecting interchangeability, assembly, or operation.
11	Insulation damage not causing possible mechanical or electrical failure.
12	Incomplete removal of soldering flux residue.
13	Other evidence of poor workmanship not affecting the function of the fuse.

4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the manufacturer may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

4.6.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table III, in the order shown, and shall be made on sample units which have been subjected to and have passed group A inspection.

TABLE III. Group B inspection.

Inspection	Requirement paragraph	Method paragraph
Current-carrying capacity - - - - -	3.7	4.7.3
Watts loss - - - - -	3.8	4.7.4
Overload interrupt - - - - -	3.9	4.7.5

4.6.1.3.1 Rejected lots. If an inspection lot is rejected, the manufacturer may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

4.6.1.3.2 Disposition of sample units. Sample units subjected to group B inspection shall not be delivered on the contract or purchase order.

4.6.2 Qualification verification inspection. Qualification verification inspection shall consist of group C. Except where the results of this inspection show noncompliance with the applicable requirement (see 4.6.2.1.4), delivery of products which have passed groups A and B shall not be delayed pending the results of this qualification.

4.6.2.1 Group C inspection. Group C inspection shall consist of the interrupting capacity rating test (see 3.10 and 4.7.6). Group C inspection shall be made on sample units selected from lots which have passed groups A and B inspections, unless the Government considers it more practical to select a sample from current production. A manufacturer's normal quality control and production tests may be used to fulfill group C inspection.

4.6.2.1.1 Sampling plan. Samples shall be selected at random. Fifteen each of the maximum and minimum ratings shall be selected from those covered on a single specification sheet, 12 months after the date of notification of qualification and after each subsequent 12-month period.

4.6.2.1.2 Failures. If one or more sample units fail to pass group C inspection, the sample shall be considered to have failed.

4.6.2.1.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or purchase order.

4.6.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which are manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action acceptable to the qualifying activity has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all tests and examinations, or the test which the original sample failed, at the option of the qualifying activity). Groups A and B inspections may be reinstated; however, final acceptance and shipment shall be

withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.6.3 Inspection of packaging. Except for industrial packaging, the sampling and inspection of the preservation, packing, and interior package marking shall be in accordance with the groups A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129. The inspection of industrial packaging shall be as specified in the contract or purchase order (see 6.2).

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination. Fuses shall be examined to verify that the material, design and construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1 through 3.5.3, 3.14, and 3.15).

4.7.2 Terminal strength (see 3.6). Terminals shall be tested in accordance with method 211 of MIL-STD-202, test condition E. Torque shall be as specified (see 3.1).

4.7.3 Current carrying capacity (see 3.7). Fuses shall be subjected to an alternating current, of any convenient voltage, at the specified percentage of rated current (see 3.1). Each fuse shall be mounted in such a position that its major axis is horizontal. The current shall be maintained until the temperature has stabilized.

4.7.3.1 Classes G, J, R, and K fuses. It may be assumed that the temperature has stabilized when three successive temperature readings, taken at 5-minute intervals, indicate no increased rise above the temperature of the ambient air. The temperature of the fuse case, or body, and of the terminals shall be measured using a standard all-glass mercury thermometer. The thermometer shall be supported so that the angle of its stem and the vertical shall not exceed 60 degrees. Contact between the bulb and the fuse will be insured by completely covering the bulb with glazing putty. The test shall be conducted in still air with the ambient temperature within 18°C to 32°C (65°F to 90°F) provided the air temperature does not vary more than 5°C (9°F) during the test. When two or more fuses are tested in series, the fuseholders shall be located so that there will be a spacing of not less than 6 inches between any two fuses. The wire connecting the fuseholders, ammeter, and the source of supply shall be in accordance with J-C-30 and shall be of the size specified in table IV. For fuses rated at more than 60 amperes, C clamps or suitable clip clamps shall be used to insure adequate contact. C clamps shall be of iron or steel, weighing not more than 3 ounces and neither face of the clamp in contact with the fuseholder terminals shall have an area exceeding 1/2 square inch. For fuses rated at 60 amperes or less, a pressure-type fuseholder shall be used to insure adequate contact between the clips and the ferrules of the fuse.

TABLE IV. Wire test leads.

Fuse rating in amperes	Wire	
	Minimum length in feet ^{1/}	Size ^{2/}
0-30	2	8 AWG
31-60	2	4 AWG
61-100	2	1 AWG
101-200	2	4/0 AWG
201-400	4	500 MCM
401-600	4	1,000 MCM

^{1/} Any connection to the source of supply shall be not less than 4 feet.

^{2/} Connections larger than 8 AWG shall employ a suitable soldering lug or pressure wire connector.

4.7.3.2 Class L fuses. It may be assumed that the temperature has stabilized when three successive readings taken at intervals of 10 percent of the previous elapsed duration of the test, but not less than 10-minute or more than 20-minute intervals, indicate no change. The temperature during the test shall be made with iron and constantan thermocouples using 30 AWG wires. Attachment shall be in the center of the fuse terminal approximately 1/4 inch from the outer edge of the fuse body on the side opposite the terminal bus-bar connection. The fuse under test shall be bolted to a silver plated copper bus-bar with a rectangular cross-sectional area as specified in table V. The bus-bar shall be at least as wide as the terminal or blade of the fuse being tested. The test current shall be as specified in table V. The equipment shall be calibrated using a dummy fuse substituted for the fuse to be tested. The dummy fuse shall be a rectangular silver plated copper bus-bar approximately the same length as the fuse to be tested. The dummy fuse may be one piece or laminated, without space between the laminations. The temperature rise of the dummy fuse shall be within the limits specified in table V. The thermocouples shall be attached to the dummy fuse at the approximate center and on the side opposite the terminal bus-bar connections.

TABLE V. Bus-bar cross-section and dummy fuse temperature rise.

Ampere rating	Test current (amperes)	Maximum bus-bar cross-section (sq inches)	Dummy fuse temperature rise	
			Maximum	Minimum
800	880	3/4	35°C (63°F)	20°C (36°F)
1000	1100	1	35°C (63°F)	20°C (36°F)
1200	1320	1	35°C (63°F)	20°C (36°F)
1600	1760	2	35°C (63°F)	20°C (36°F)
2000	2200	3	35°C (63°F)	20°C (36°F)
2500	2750	4	35°C (63°F)	20°C (36°F)
3000	3300	4 1/2	45°C (81°F)	30°C (54°F)
4000	4400	6	60°C (108°F)	40°C (72°F)
5000	5500	9	70°C (126°F)	50°C (90°F)
6000	6600	9	85°C (153°F)	65°C (117°F)

4.7.4 Watts loss (see 3.8). Fuses shall be mounted in suitable open clip type fuseholders and shall be subjected to rated current until the temperature is stabilized (see 4.7.3.1). The voltage drop shall be taken across the geometric centers of the ends of the terminals. The average watts loss is calculated as follows:

- a. Five fuses are subjected to test.
- b. The results of the highest and lowest voltage drops are to be disregarded.
- c. The voltage drop for each of the remaining fuses shall be multiplied by the rated current of the fuse. The sum of the product of these three fuses shall be divided by 3 which shall be the average watts loss.

4.7.5 Overload interrupt (see 3.9). Fuses shall be subjected to the overloads as specified (see 3.1), using a power supply of any convenient voltage. The fuse shall open the circuit as specified (see 3.1). Fuses shall be tested singularly. Overload tests shall start at an ambient room temperature of 25°C (77°F) with the following allowable tolerances:

- a. Classes G, J, and L - ±5°C (9°F)
- b. Classes K1, K5, K9, RK1, and RK5 - ±7°C (13°F)

The ambient temperature shall not vary more than 5°C (9°F) during the test.

4.7.5.1 Opening at rated voltage (see 3.9.1). Classes G, J, K1, K5, K9, RK1, and RK5 fuses shall be subjected to an overload of 200 percent of rated current (-0, +10 percent) with a power factor of 80 percent or less (see UL198C, UL198D, or UL198E). The open circuit voltage shall be not less than the rated voltage at a frequency of 48 to 60 hertz. The fuse may be preconditioned in an air oven having an average temperature of 90°C (194°F) for at least 24 hours prior to testing. Class G fuses shall also be subjected to currents of 5,000, 2,000, 1,000, 500, and 250 rms symmetrical (± 10 percent) amperes at 480 volts and a frequency of 48 to 60 hertz. The closing angle shall be at random.

4.7.6 Interrupting capacity rating (see 3.10). Fuses shall be tested as described herein in accordance with the applicability as shown in table I. For additional information on the calculation and determination of power factors, circuit calibration, restrike, and instrumentation, the provisions and applicable portions of UL198C, UL198D, or UL198E shall apply. All tests shall be supported with photographic oscillographic records and may be enlarged to enable accurate measurement.

4.7.6.1 Interrupting ability. Fuses shall be tested on a circuit having an available rms symmetrical current not less than 100 percent or greater than 120 percent of the interrupting capacity rating (see 3.1), and shall be rated frequency (see 3.1). The closing angle shall be essentially at the zero of the voltage wave (maximum offset) or later, to produce start of arcing within 30 electrical degrees prior to system peak voltage. The fuse shall be entirely surrounded by and in intimate contact with untreated surgical cotton. Fuses shall be tested within 1 hour of removal from a 90°C (194°F) oven after at least 24 hours conditioning.

4.7.6.2 Maximum energy. Fuses shall be subjected to an rms symmetrical current (if not greater than the interrupting capacity rating of the fuse) such that the fuse permits a peak current let-thru of 70 to 100 percent of the peak value of the symmetrical component of the alternating current of the circuit at a power factor of 20 percent or less. The voltage shall be not less than rated voltage (see 3.1), and at rated frequency (see 3.1). The closing angle shall produce start of arcing within 30 electrical degrees prior to system peak voltage. The fuse shall be entirely surrounded by and in intimate contact with untreated surgical cotton. Fuses are to be tested within 1 hour of removal from a humidity chamber after conditioning at room temperature and 90 to 100 percent relative humidity for 5 days. This test shall be conducted whether or not the let-thru current for the interrupting ability test falls between 70 and 100 percent of the available current, since different pretesting conditions are imposed on the fuse.

4.7.6.3 Intermediate interrupting ability. Fuses shall be subjected to an rms symmetrical current below the interrupting capacity rating of the fuse - 100,000 amperes (± 10 percent), 50,000 amperes (± 10 percent), and 25,000 amperes (± 10 percent), at a power factor of 20 percent or less. The voltage shall be not less than specified (see 3.1), and at rated frequency (see 3.1). The closing angle shall be adjusted to cause start of arcing within 30 electrical degrees prior to system peak voltage. The fuse shall be entirely surrounded by and in intimate contact with untreated surgical cotton and shall be tested within 1 hour of removal from a 90°C (194°F) oven after at least 24 hours conditioning.

4.7.6.4 Low interrupting ability. Fuses shall be subjected to an rms symmetrical current of not less than 10,000 amperes nor more than 11,000 amperes at a power factor of 50 percent or less. The voltage shall be not less than rated voltage (see 3.1), and at rated frequency (see 3.1). The instant of closure shall be at random with reference to the phase of the voltage wave. Oscillographic records are not required.

4.7.7 Threshold ratio (see 3.11). Fuses shall be subjected to an available rms symmetrical current of not more than the product of the fuse current rating and the threshold ratio (see 3.1), for the fuse being tested. The voltage shall be not less than rated voltage (see 3.1), and the frequency shall be as specified (see 3.1). Oscillographic records shall be used to determine that the circuit was cleared as specified (see 3.11).

4.7.8 Peak let-thru current (see 3.12). Fuses shall be subjected to rms symmetrical currents of 25,000 amperes (if not below threshold), 100,000 amperes, and 200,000 amperes (if not above the interrupting capacity rating). Tolerance on currents is +20, -0 percent. The power factor shall be 20 percent or less. The closing angle shall be essentially at zero of the voltage wave (maximum offset) or later, so as to produce start of arcing within 30 electrical degrees prior to system peak voltage. The peak let-thru current shall not exceed the value specified (see 3.1) when tested on circuits between threshold current and the interrupting capacity rating of the fuse. The test voltage shall be not less than rated voltage (see 3.1). The maximum peak voltage occurring during the interruption shall be not more than 3000 volts. This voltage shall be measured with an instrument having a frequency response that is linear from 50 to 3000 hertz.

4.7.9 Maximum clearing I²T (see 3.13). The maximum clearing I²T shall be determined from an oscillogram showing the current trace obtained in 4.7.8. The determination shall be made by application of Simpson's rule or the use of an integrating planimeter as shown in UL198C, UL198D, or UL198E.

5. PREPARATION FOR DELIVERY

5.1 Preservation. Preservation shall be level A or industrial, as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning. Fuses shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Fuses shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. Preservatives shall not be used.

5.1.1.4 Unit packs. Fuses shall be packed in accordance with MIL-P-116, method 111, insuring compliance with the applicable requirements of that specification. The quantity per unit pack (QUP) and unit container requirements shall be as specified in 5.1.1.4.1 through 5.1.1.4.5.

5.1.1.4.1 Fuses, 0-60 amperes. These fuses shall be unit packed in unit containers conforming to PPP-B-566 or PPP-B-676. The QUP shall be 5 each or 10 each, as specified (see 6.2).

5.1.1.4.2 Fuses, 61-100 amperes. These fuses shall be unit packed in unit containers conforming to PPP-B-566 or PPP-B-676. The QUP shall be one each or as specified (see 6.2).

5.1.1.4.3 Fuses, 101-600 amperes. These fuses shall be packed one each in unit containers conforming to PPP-B-566 or PPP-B-676.

5.1.1.4.4 Fuses, 601-2000 amperes. These fuses shall be unit packed one each in unit containers conforming to PPP-B-566, PPP-B-676, PPP-B-665, or PPP-B-636.

5.1.1.4.5 Fuses, 2001-6000 amperes. These fuses shall be unit packed one each in unit containers conforming to PPP-B-636.

5.1.1.5 Intermediate packs. Fuses packed as specified in 5.1.1.4.1 shall be placed in intermediate containers conforming to PPP-B-566 or PPP-B-676. Intermediate containers shall be uniform in size, shape, and quantities; shall be of minimum tare and cube; and shall contain multiples of 5 unit packs, not to exceed 100 unit packs. No intermediate packs are required for fuses rated at more than 60 amperes or when the total quantity shipped to a single destination is less than 100 unit packs.

5.1.2 Industrial. The industrial preservation of fuses shall be in accordance with the requirements of MIL-STD-1188.

5.2 Packing. Packing shall be level A, B, or industrial as specified (see 6.2).

5.2.1 Level A. The packaged fuses shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. The requirements for box closure, waterproofing, and reinforcing shall be in accordance with method V of the PPP-B-636 appendix.

5.2.2 Level B. The packaged fuses shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirements. Closures shall be in accordance with the appendix thereto.

5.2.3 Industrial. The preserved fuses shall be packed in accordance with the requirements of MIL-STD-1188.

5.2.4 Unitized loads. Unitized loads, commensurate with the level of packing specified in the contract or purchase order, shall be used whenever total quantities for shipment to one destination equal 40 cubic feet or more. Quantities less than 40 cubic feet need not be unitized. Unitized loads shall be uniform in size and quantities to the greatest extent practicable.

5.2.4.1 Level A. Fuses packed as specified in 5.2.1 shall be unitized on pallets in conformance with MIL-STD-147, load type I, with a fiberboard cap (storage aid 4) positioned over the load.

5.2.4.2 Level B. Fuses packed as specified in 5.2.2 shall be unitized as specified in 5.2.4.1, except that the fiberboard cap shall be class domestic.

5.2.4.3 Industrial. Fuses packed as specified in 5.2.3 shall be unitized in accordance with the contractor's commercial practice.

5.3 Marking. The complete Government part number and manufacturer's part number shall be marked on all unit and intermediate packages. In addition to any special or other identification marking required by the contract or purchase order (see 6.2), each unit pack, intermediate and exterior container, and unitized load shall be marked in accordance with Fed. Std. No. 123 for civil agency acquisitions and in accordance with MIL-STD-129 for military (DoD) acquisitions. Bar code markings are required for DoD acquisitions. Industrial marking shall be as specified in MIL-STD-1188.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2, and 5.2.3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Army acquisitions.

5.4.2.1 Level A unit and intermediate packs. All unit and intermediate containers shall either be weather (or water) resistant or over-wrapped with waterproof barrier materials. Containers conforming to PPP-B-566 or PPP-B-676 shall be overwrapped with waterproof barrier materials (see 5.1.1.4 and 5.1.1.5).

5.4.2.2 Level A and level B packing. For level A packing when quantities per destination are less than a unitized load, the fiberboard containers shall not be banded but shall be placed in a close fitting box conforming to PPP-B-601, overseas type; PPP-B-621, class 2, style 4; or PPP-B-585, class 3, style 2 or 3. Closure and strapping shall be in accordance with applicable container specification except that metal strapping shall conform to QQ-S-781, type I, finish A. When the gross weight exceeds 200 pounds or the container length and width is 48 x 24 inches or more and the weight exceeds 100 pounds, 3 x 4 inch skids (laid flat) shall be applied in accordance with the requirements of the container specification. If not described in the container specification, the skids shall be applied in a manner which will adequately support the item and facilitate the use of material handling equipment. For level B packing, fiberboard boxes shall be weather resistant, as specified in level A, and the containers shall be banded (see 5.2.1 and 5.2.2).

5.4.2.3 Level A and level B unitization. Palletization shall be required when containers specified in 5.4.2.2 do not require skids, when quantities per destination exceed either a total of 250 pounds (excluding the pallet), or when the volume equals 20 cubic feet or more and the container size permits the use of one of the pallet patterns of MIL-STD-147. A quantity of containers packed as specified in 5.4.2.2, except that the container strapping may be omitted, shall be placed on a pallet, load type I, conforming to MIL-STD-147. The pallet shall conform to NN-P-71, type IV, using group I or II woods. The loads shall be bonded to the pallet by strapping conforming to QQ-S-781, type I, finish A, or shrink film conforming to L-P-378, type IV. Stretch wrap in accordance with MIL-STD-147 is authorized for shipments within the continental U.S. and for all containerized shipments.

6. NOTES

6.1 Intended use. Fuses furnished to this specification and listed by Underwriters Laboratories Inc. are intended for use in accordance with the National Electrical Code (NFPA No. 70-1971; ANSI C1-1971). These fuses are designed for use on circuits which may be subjected to high short circuit currents, and these fuses are capable of limiting the peak let-thru current and maximum clearing i^2t (see 3.1 and 3.3).

6.1.1 Class G fuses. These fuses provide safe protection for circuits in homes, commercial buildings, and industrial plants of 120/208, 120/240, and 277/480 volts (not to exceed 300 volts line to ground).

6.1.2 Class J fuses. These fuses provide safe protection on circuits of 600 volts or less that have available short circuit currents up to 200,000 amperes. These fuses are fast (no time delay) and are current limiting.

6.1.3 Class K fuses. These fuses have the same National Electrical Code dimensions as class H fuses (W-F-1726) but differ from class H in that they have a high interrupting rating. The class K fuses have varying degrees of current limiting ability but may not be designated as current limiting. Class K fuses are divided into subclasses as follows:

- a. K1 - Highest degree of current limitation characteristics; interrupting capability up to 200,000 amperes.
- b. K5 - Medium degree of current limitation characteristic. Time delay - shall not open in less than 10 seconds at 500 percent of rated current, interrupting capability up to 200,000 amperes.
- c. K9 - The lowest degree of current limitation characteristic. Same time delay as the K5, but an interrupting capability up to 100,000 amperes.

6.1.4 Class R fuses. These fuses have the same overall National Electrical Code dimensions as classes H and K fuses but differ by possession of a "rejection feature" which prevents them from being used in a fuseholder for a class H or K fuse. These fuses are current limiting and are divided into subclasses as follows:

- a. RK1 - Highest degree of current limiting characteristic; interrupting capability up to 200,000 amperes.
- b. RK5 - Medium degree of current limiting characteristic; interrupting capability up to 200,000 amperes.

6.1.5 Class L fuses. These fuses consist of the larger current ratings (600 to 6000 amperes) and are used on circuits of 600 volts or less that have available short circuit currents up to 200,000 amperes. These fuses provide safe current limiting protection when properly bolted to bus bars. They have no intentional time delay.

6.1.6 Interchangeability of classes H, K, and R fuses. Fuses which have the same amperage, voltage, and time delay ratings are one-way interchangeable between classes as follows:

- a. RK1 may be used in lieu of RK5, K1, K5, K9, and H.
- b. RK5 may be used in lieu of K5, K9, and H.
- c. K1 may be used in lieu of K5, K9, and H.
- d. K5 may be used in lieu of K9 and H.
- e. K9 may be used in lieu of H.

6.2 Ordering data. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Title, number, and date of the applicable specification sheet.
- c. Government part number (see 3.1).
- d. Fuse ratings not listed in applicable specification sheets (see 3.1.1).
- e. Inspection of industrial packaging (see 4.6.3).
- f. Levels of preservation-packaging and packing required (see 5.1 and 5.2).
- g. Quantity of fuses per unit package (see 5.1.1.4.1 and 5.1.1.4.2).
- h. Special or other identification marking, if required (see 5.3).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the contractor is called to this requirement, and manufacturers are urged to arrange to have the products they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Defense Electronics Supply Center, ATTN: DESC-E, Dayton, OH 45444, and information pertaining to qualification of products may be obtained from that activity.

6.3.1 Application for qualification. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification" which may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.4 Supersession data. This specification includes the requirements for classes G, J, K1, K5, K9, RK1, RK5, and L fuses and supersedes the remaining portion of W-F-791d, dated November 27, 1963 and Interim Amendment 1, dated February 18, 1966.

6.4.1 Background. Previous designations of type, style, and class were nondefinitive since precise information was lacking to insure uniformity in part number construction. A major part numbering change was devised and utilized in W-F-791E and W-F-1726. The same system is also used in W-F-1814. This method of numbering will insure uniformity and aid in prevention of duplicate items entering the system.

MILITARY INTERESTS:

Custodians

Army - ER
Navy - YD
Air Force - 85

Review Activities

Army - AT, ME, AL
Air Force - 99
DLA - ES
NS

User Activities

Army - AR
Navy - OS

CIVIL AGENCY COORDINATING ACTIVITIES:

AEC - AEC
COMMERCE - NBS
DOT - ACU, FIS
GPO - GPU
GSA - OPP
JUSTICE - FPI
NASA - JFK, LRC
USPS - POS
VA - USS

PREPARING ACTIVITY:

DLA - ES

(Project 5920-0392)