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Mechanically and Electrically Operated Fuel Pumps for Marine Use

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Mechanically and Electrically Operated Fuel Pumps for Marine Use, UL 1130

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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 and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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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 which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, 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.

INTRODUCTION

1 Scope

1.1 The requirements in this standard apply to the construction and performance characteristics of fuel pumps intended for marine use that are:

a) Mechanically operated; or

b) Electrically operated and rated 50 volts dc or less,

and that are intended for use on recreational boats. The standard covers both independently mounted pumps and integrally mounted pumps used with engines or accessory devices. The standard also addresses pumps used to transfer fuel between tanks. Pumps covered by this Standard may be used with gasoline, diesel fuel, or both.

1.2 The requirements also cover accessories such as oil pressure switches, if provided, for use with the pump.

1.3 The pumps covered by these requirements are intended for installation and use in accordance with the applicable requirements of the U.S. Coast Guard (as specified in 33 CFR 183 Subpart J – Fuel Systems and 33 CFR 183 Subpart I – Electrical Systems), the standards of the American Boat and Yacht Council, Inc., and the Standard for Fire Protection of Pleasure and Commercial Motorcraft, NFPA 302.

1.4 These requirements do not cover mechanically or electrically operated marine fuel pumps intended for use in hazardous locations as defined in the United States Coast Guard Electrical Engineering Regulations. See 46 CFR Section 111.105-1.

1.5 These requirements cover ignition-protected pumps (for use with gasoline) that may be required on boats under 65 feet (19.8 m) in length. Pumps for use with diesel fuel are not required to be ignition protected.

1.6 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, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable 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 cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 Glossary

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

2.2 FUEL TRANSFER PUMP – A pump intended to transfer fuel between tanks.

2.3 IGNITION-PROTECTED – Constructed so that:

a) A flammable hydrocarbon mixture surrounding the device will not be ignited if a normally occurring electrical arc, spark, or heat source ignites a flammable hydrocarbon mixture inside the device;

b) The electrical arc, spark, or heat source inside the device has insufficient energy to ignite the flammable mixture; or

c) The source of ignition is hermetically sealed from the surrounding mixture.

An ignition-protected device does not necessarily comply with the requirements for an explosion-proof device. See 1.4.

2.4 PUMP – All mechanically or electrically operated fuel pumps. Refer to Table 13.1 for the applicable tests which are to be performed on a pump.

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 Components

4.1 Except as indicated in 4.2, a component of a pump covered by this standard shall comply with the requirements for that component.

4.2 A component need not comply with a specific requirement that:

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

b) Is superseded by a requirement in this standard.

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

4.4 Specific components are recognized as being 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 for which they have been recognized.

CONSTRUCTION

5 General

5.1 A pump shall be constructed to withstand the environmental effects of pressure, vibration, shock, and other conditions specified in Sections 14 – 26.

5.2 All metallic parts shall be galvanically compatible and resistant to corrosion in marine atmospheres. Castings, if used, shall be free of porosity, sandholes, or other imperfections likely to cause leakage.

5.3 Materials not known to provide acceptable resistance to corrosion, dezincification resistance, or galvanic compatibility between parts shall be subjected to the Salt Spray Corrosion Test, Section 14.

5.4 A gasket or ″O″ ring shall be retained by the body, or cover, when the cover is removed.

5.5 A steel component shall be plated with zinc, cadmium, or other equivalent finish coating resistant to corrosion, bilge cleaning solvents, and petroleum products.

5.6 A brass fitting shall have less than 15 percent zinc content. If the zinc content exceeds 15 percent, the fitting shall comply with the 10-Day Moist Ammonia-Air Stress Cracking Test, Section 24.

5.7 A pump shall be liquid- and vapor-tight as specified in the Fire and Thermal Shock Test, Section 25.

5.8 A pump for use with gasoline shall comply with the Standard for Ignition-Protection Tests for Marine Products, UL 1500.

5.9 A diaphragm pump shall be constructed so that there will be no external leakage to the engine compartment if the primary diaphragm malfunctions. If it is not obvious that external leakage is controlled, an appropriate test shall be conducted.

5.10 A pump shall be constructed such that it will be installed on the engine it serves or within 12 inches (304.8 mm) of the engine, unless it is a fuel transfer pump.

5.11 An independently mounted pump shall be provided with a means for electrical grounding or bonding.

6 Electric Fuel Pumps

6.1 An electrically operated fuel pump shall be provided with:

a) An oil pressure switch so that the pump does not operate except when the engine is operating or when the engine is being started (see Operation Test, Section 23); or

b) The marking specified in 27.5 and the instructions described in 28.3.

6.2 All wiring practices shall be in accordance with 33 CFR 183 Subpart I – Electrical Systems and with Section 8 of this Standard.

6.3 An oil pressure switch, if provided, shall comply with the Standard for Ignition-Protection Tests for Marine Products, UL 1500.

7 Nonmetallic Materials

7.1 A nonmetallic material, or finish coating, that is exposed to bilge water shall be resistant to deterioration by gasoline, oil, kerosene, and salt water. See Materials Test, Section 19.

8 Internal Wiring

8.1 The wiring and connections between parts of a pump shall be mechanically protected or enclosed.

8.2 All conductors, other than short internal jumpers and those in wound coils, shall be stranded copper in accordance with Table 8-14.4 in the Standard for Pleasure and Commercial Motor Craft, NFPA 302.

8.3 A hole in a wall or partition through which insulated wires or cords pass shall be provided with a smooth rounded bushing, or the hole shall have a smooth rounded surface to prevent abrasion of the insulation.

8.4 Internal wiring shall have insulation rated for the potential and temperature to which it may be subjected, and shall be a minimum of No. 18 AWG (1.0 mm^2). Thermoplastic-insulated wire employed for internal wiring shall be suitable for marine use or appliance wiring material intended for use in moist or wet locations with a minimum temperature rating of 90°C (194°F) and shall be flame resistant.

8.5 If stranded internal wiring is connected to a wire-binding screw, loose strands of wire shall be prevented from contacting other uninsulated live parts and dead-metal parts. This may be accomplished by the use of pressure terminal connectors, crimped eyelets, or by other equivalent means.

9 Field Power Supply Connections

9.1 A pump shall be provided with:

a) Field wiring terminals for connection of power supply conductors; or

b) Pigtail leads.

9.2 Supply conductors shall be No. 16 AWG (1.3 mm^2) or larger and shall:

a) Be of stranded copper construction that has insulation complying with the moisture-resistance and flame-retardance requirements in the Standard for Rubber-Insulated Wires and Cables, UL 44, or in the Standard for Thermoplastic-Insulated Wires and Cables, UL 83 (Type RHW, THW, or the like);

b) Be gasoline and oil resistant; and

c) Have a minimum temperature rating of 90°C (194°F).

The temperature rating of insulation shall not be less than temperatures recorded on lead wires measured during the Temperature Test, Section 17.

9.3 Terminals shall be located or enclosed to reduce the likelihood of water accumulating between terminals of opposite polarity and between the terminals and ground.

9.4 An exposed metallic part of a pump shall have provision for connection of a bonding conductor unless the part is isolated from all current-carrying parts by independent insulation provided in addition to the basic insulation. See Stray Current Leakage Test, Section 18.

10 Strain Relief

10.1 A pigtail connection employed for field wiring connections shall be provided with strain relief so that a stress on the lead will not be transmitted to terminals, splices, or internal wiring and shall comply with the Strain Relief Test, Section 26.

11 Insulating Material

11.1 Material for mounting uninsulated current-carrying parts shall be phenolic composition or other material acceptable for a marine environment.

12 Motor Protection

12.1 A pump shall be protected against stalled-rotor conditions by one of the following means:

a) The motor incorporates a protector that complies with the stalled motor requirements of the Standard for Overheating Protection for Motors, UL 2111.

b) The pump is marked (in accordance with 27.2) that it is to be protected by an overcurrent means. The means to be used shall:

1) Be specified by the manufacturer;

2) Be acceptably rated for the application; and

3) Comply with the requirements of the Fuse Protection Test, Section 20.

12.2 A pump shall comply with either the Fuse Protection Test, Section 20, or the Locked Rotor Test, Section 21. A locked rotor test is to be conducted on pumps that have a rotating shaft or impeller that can be locked, unless the pump is to be protected in accordance with 12.1(b). If the construction of a pump is such that the locked rotor test is not applicable, (for example pumps without rotating shafts) the pump is to be tested in the manner which produces the highest external temperatures and shall comply with the requirements of the Fuse Protection Test, Section 20. Integral thermal protection may be utilized on pumps for which the locked rotor test is not applicable, but these pumps shall comply with the Fuse Protection Test.

PERFORMANCE

13 General

13.1 A pump shall be subjected to Test Sets I and II specified in Table 13.1 without any increase in the risk of fire, electric shock, or injury to persons. Tests in Set I are to be performed on a single fuel pump and in the order presented except for Section 21 in which 3 are to be used. Tests in Set II are to be performed in any order.

Table 13.1
Test sets

Set	Tests	Section
I	Vibration Test	15
	Shock Test	16
	Temperature Test	17
	Stray Current Leakage Test	18
	Materials Test	19
	Fuse Protection Test[a]	20
	Locked Rotor Test	21
	Salt Spray Corrosion Test[b]	14
	Ignition Protection Test	22
II	Salt Spray Corrosion Test[c]	14
	Operation Test	23
	10-Day Moist Ammonia Air Stress Cracking Test	24
	Fire and Thermal Shock Test	25
	Strain Relief Test	26

[a] To be conducted as appropriate.
[b] The test is to be conducted for 240 hours.
[c] The test is to be conducted for 1800 hours.

13.2 An accessory (such as an oil pressure switch or a pressure regulator) provided with the pump shall be evaluated for its intended use in accordance with the applicable requirements in Sections 14 – 26.

14 Salt Spray Corrosion Test

14.1 A fuel pump containing a metallic part, including its mounting brackets, if not known to provide an acceptable level of resistance to corrosion, shall be subjected to the following salt spray conditions:

a) 240 hour exposure as a pre-condition for the Ignition Protection Test (Test Set I).

b) 1800 hour exposure (Test Set II), after which the pump shall be operated at maximum output pressure and at maximum flow rate to determine that no leaks result from the exposure.

14.2 The sample is to be supported and exposed to salt spray (fog) as specified in the Standard Method of Salt-Spray (Fog) Testing, ASTM B117-73 (1979). The duration of the exposure is to be as described in 14.1.

15 Vibration Test

15.1 A pump shall withstand the test described in 15.2 – 15.4 and shall operate without developing leaks, cracks, and the like, and without increasing the risk of fire or injury to persons.

15.2 The pump and all components, with the manufacturer's recommended fuel line attached, is to be mounted on a vibration machine so as to simulate as closely as possible an actual installation. The means used for such mounting shall be sufficiently rigid to preclude resonant frequencies of the mounting means. The vibration machine is to produce the vibration frequencies and amplitude specified in 15.3.

15.3 The pump is to be subjected to variable frequency vibration along each of three axes (horizontal, lateral, and vertical) for 8 hours in each plane (24 hours total) at a peak-to-peak amplitude of 0.040 ±0.001 inches (1.3 ±0.00004 mm). The frequency of vibration is to be continuously varied, at a uniform rate, from 10 to 60 to 10 hertz every 4 minutes.

15.4 For this test, peak-to-peak amplitude is defined as the maximum displacement of sinusoidal motion (total table displacement).

16 Shock Test

16.1 A pump, including all components, used for the Vibration Test shall withstand the test described in 16.2 – 16.5 and shall operate without developing leaks, cracks, and the like, and without increasing the risk of fire, electric shock, or injury to persons.

16.2 The pump, including all components, is to be mounted on a shock machine in the same manner as described in the Vibration Test (15.2 and 15.3). The shock machine is to produce repeated shock pulses as specified in 16.3.

16.3 The pump is to be subjected to 5000 shock impacts of 10g acceleration (98 m/s^2) and having a shock duration of 20 – 25 milliseconds as measured at the base of the half-sine shock envelope.

16.4 The machine used for this conditioning is to be of the automatic cycling type capable of producing a half-sine shock pulse at the acceleration level and duration specified.

16.5 The pump is to be mounted so that the center of gravity of the sample is as close as possible to the geometric center of the machine platform.

17 Temperature Test

17.1 A pump shall be capable of operation within an ambient temperature range of minus 30°C (-22°F) to 90°C (194°F) without malfunction or leakage. The pump shall operate at maximum pressure. No external temperatures shall exceed 150°C (302°F). Measured temperatures on the wire or on any part of the pump (including supply wires) shall not exceed the temperature rating of the wire insulation used.

17.2 The pump is to be placed in a cold chamber for 48 hours at minus 30°C ±3°C (minus 22°F ±5°F). The pump is to be operated with a kerosene class fuel for:

a) 24 hours at 85 percent rated voltage; and

b) 24 hours at 120 percent rated voltage.

17.3 Immediately following the test in the cold chamber, the pump is to be placed in a heated chamber for 48 hours at 90°C ±3°C (194°F ±5°F). The pump is to be operated with a kerosene class fuel for:

a) 24 hours at 85 percent rated voltage; and

b) 24 hours at 120 percent rated voltage.

17.4 Thermocouples are to be attached to the:

a) External surface of the pump;

b) Supply wires; and

c) Motor field windings or solenoid (wiring),

to record operating temperatures of electric fuel pumps during the testing in 17.2 and 17.3.

18 Stray Current Leakage Test

18.1 A pump shall be capable of withstanding a voltage of 500 volts dc for 1 minute without current leakage in excess of 1 milliampere.

18.2 The test is to be conducted with the pump still in a heated condition following the high temperature test in 17.3.

18.3 The test voltage is to be applied between the current-conducting parts of the pump and dead-metal parts. When the test is applied to internally grounded pumps, the ground connection is to be disconnected prior to the test.

18.4 The test voltage is to be applied at a rate of approximately 50 volts per second until the test potential is reached.

19 Materials Test

19.1 Immersion

19.1.1 A nonmetallic part described in 7.1, which contacts any of the fluids indicated in Table 19.1, shall not show a volume change or loss of weight (see 19.2) that would impair its intended function following partial immersion (approximately one-half) for 70 hours at 23 ±2°C (73.4 ±3.6°F) in the specified test liquid.

Table 19.1
Test liquids

Fluid in Contact with Part	Test Liquid
Fuel Oils Nos. 2 – 6	IRM immersion oil 903
Gasoline	Reference Fuel C (ASTM D471-1996)

19.1.2 A change in volume of not more than 25 percent swelling (40 percent in Reference Fuel C) or 1 percent shrinkage, and a weight loss (extraction) of not more than 10 percent is considered as indicating compliance with 19.1.1.

19.2 Accelerated aging

19.2.1 A synthetic rubber material part which may be affected by aging shall not crack or show visible evidence of deterioration following exposure in an air circulating oven at 121°C (250°F) for 10 days. Vinyl materials are to be aged at 121°C for 7 days or at 97°C (207°F) for 60 days. The test procedure is to be in accordance with the Standard Test Method for Rubber – Deterioration in an Air Oven(E1-1994)(R1994), ASTM D573 (1988).

20 Fuse Protection Test

20.1 If a fuse is needed to comply with the motor protection requirements specified in Section 12, the pump and fuse shall be tested in accordance with 20.2 – 20.6. There shall be no emission of flame or molten metal and no external temperatures in excess of 150°C (302°F) before or after the fuse opens when a pump is subjected to the tests described in 20.2 – 20.6.

20.2 The pump is to be placed in an air circulating oven at an ambient temperature of 90°C (194°F). The fuse is to be located outside of the oven at an ambient temperature of 23 ±2°C (72 ±5°F).

20.3 While the pump is in the oven, thermocouples are to be installed on the housing of the pump in at least four locations so as to record the maximum external surface temperatures.

20.4 The pump is then to be connected to 85 percent of rated voltage and the circuit is to be protected by the overcurrent protection device (fuse) recommended by the manufacturer. The fuse is to be installed in the worst case condition within the guidelines of the manufacturer's operating instructions. The fuse is to be installed using an ignition protected fuseholder recommended or supplied by the manufacturer.

20.5 The pump is to be operated in a locked rotor or overload condition, whichever condition results in the highest external temperatures. The fuse is to open before temperatures on the pump reach 150°C (302°F). After the overcurrent protection device opens, temperatures are to be monitored until the temperatures begin to decrease.

20.6 The test is then to be repeated in the overload or locked rotor condition described in 20.4 and 20.5 at 120 percent of rated voltage.

21 Locked Rotor Test

21.1 If a pump is not subjected to the fuse protection test in accordance with Section 12, the pump shall be subjected to the locked rotor test described in 21.2 – 21.4. There shall be no emission of flame or molten metal and no external temperatures in excess of 150°C (302°F) when each of three samples of the pump is subjected to a locked rotor test.

21.2 The pump is to be prepared in accordance with 20.2 and 20.3. The pump is to be connected to 120 percent of rated voltage and the circuit is to be protected by an overcurrent protection device rated 50 amperes.

21.3 The pump is to be mounted on wood or other material having relatively low thermal conductivity at an ambient temperature of 23 ±2°C (72 ±5°F).

21.4 The test is to be conducted for seven hours, or until burnout of the motor or opening of the overcurrent protective device.

22 Ignition Protection Test

22.1 A pump intended for use with gasoline shall comply with the applicable requirements for Ignition-Protection Tests for Marine Products, UL 1500, and shall not ignite the specified surrounding mixture of propane and air.

23 Operation Test

23.1 Tests shall be conducted to verify the manufacturer's ratings of the following parameters within the indicated tolerances:

a) Maximum flow rate – ± 5 percent;

b) Minimum dry suction lift – zero feet + 0.5 foot; and

c) Maximum output pressure – ± 5 percent.

23.2 An electrically operated pump is to be operated on an engine or acceptable test stand in conjunction with the shut-off switch provided by the manufacturer. It is to be installed in accordance with the manufacturer's instructions. The system is to be operated under the various simulated conditions of use described in 23.1 to determine that it will function as intended without nuisance tripping of the recommended fuse.

23.3 An oil pressure switch, if provided, is to be subjected to an oil pressure of 100 psi (690 kPa) for 1000 cycles while carrying rated current at a rate of not more than 30 cycles per minute. The switch shall not leak and the pressure setting shall not change more than 10 percent of the original setting.

24 10-Day Moist Ammonia Air Stress Cracking Test

24.1 After being tested as described in 24.2 – 24.5, a brass part containing more than 15 percent zinc shall show no evidence of cracking or delamination when examined using 25X magnification.

24.2 A pump is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components or with tubing or piping. Such stresses are to be applied to the sample prior to and be effective during the test. Samples with threads, intended to be used for installing the product in the field, are to have the threads engaged and tightened to the torque specified in Table 24.1. Teflon tape or pipe compound are not to be used on the threads.

24.3 The pump fitting used in this test is to be rigidly anchored or otherwise supported. A length of appropriately sized Schedule 80 pipe (ANSI B36.1) is to be connected to a female pipe threaded section of the body, or an appropriate pipe fitting is to be connected to a male pipe threaded section, the male threads having first been lubricated with SAE No. 10 machine oil.

24.4 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

24.5 Approximately 600 ml of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inches (38.1 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia air mixture in the chamber is to be maintained at atmospheric pressure with the temperature constant at approximately 93°F (34°C).

Table 24.1
Torque requirements for threaded connections

Nominal thread size, inches	Torque	
	pound-inches	(N·m)
1	1200	(135.6)
1-1/4	1450	(163.8)
1-1/2	1550	(175.1)
2	1650	(186.4)
2-1/2	1750	(197.7)
3	1800	(203.4)

25 Fire and Thermal Shock Test

25.1 A pump shall withstand, without liquid or vapor leakage, the fire and thermal shock tests described in 25.2 – 25.6.

25.2 The pump is to be connected into a system of full size fuel piping complete with a fuel supply tank and the valves as shown in Figure 25.1. The pump is to be positioned vertically 9 ±1 inches (230 ±25.4 mm) above the liquid surface of an open pan of fuel. The fuel pan is to be approximately 8-1/2-by 14- by 1-1/2-inches (215- by 355- by 38-mm) in size.

25.3 For a pump intended for use with gasoline or with both gasoline and diesel oil fuel systems, the fuel supply tank and system as well as the open pan of fuel are to be filled with a commercial grade of n-heptane. For a pump intended for use with a diesel fuel system only, the fuel for the fire test may be IRM immersion oil 902.

25.4 The supply tank valve is to be opened and the system bled of all air by allowing fuel to run through the system from the tank to the discharge valve. With the system full of fuel, only the discharge valve is to be shut off and the pan of fuel ignited and allowed to burn for 2-1/2 minutes. During the burning, temperatures are to be recorded at 15 second intervals. At the end of the 2-1/2 minutes, the fire is to be extinguished by fully discharging a 10 pound (4.5 kg) carbon dioxide (CO_2) extinguisher. The line is not to be disturbed.

25.5 Following ignition of the fuel in the test pan, the temperatures within 1 inch (25.4 mm) of the sample and 10 inches (254 mm) above the fuel level, are to reach a minimum of 1200°F (649°C) during the 2-1/2 minute period. If 1200°F (649°C) is not attained, the test is to be repeated with a new sample. Temperatures are to be measured with a Type K thermocouple probe.