UL 1500

ISBN 0-7629-0213-2

Ignition-Protection Test for Marine Products

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Ignition-Protection Test for Marine Products, UL 1500

Third Edition, Dated September 5, 1997

Revisions: This Standard contains revisions through and including March 8, 2007.

Summary of Topics

This revision to UL 1500 includes revising the ignition of internal gas/air mixture test procedures in Section 9.

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated February 1, 2007.

The revisions dated March 8, 2007 include a reprinted title page (page1) for this Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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

Page	Date
1-7	March 8, 2007
8-10B	May 26, 1999
11-13	September 5, 1997
14-14B	March 8, 2007
15-18	September 5, 1997

No Text on This Page

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Standard for Ignition-Protection Test for Marine Products

First Edition – October, 1977
Second Edition – October, 1982

Third Edition

September 5, 1997

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

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

ISBN 0-7629-0213-2

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INTRODUCTION

1 Scope

1.1 This test procedure covers the basic test methods for determining ignition protection and is not to be considered as a test standard that will determine the acceptability of a product or component for use in marine service. The acceptability of a product or component in the intended application is judged in accordance with applicable requirements and tests for that component or product.

1.2 This test procedure does not cover explosion proof or intrinsically safe equipment as required by the U. S. Coast Guard and applied to U. S. Coast Guard inspected vessels or as defined in the National Electrical Code, ANSI/NFPA No. 70.

1.3 Products and components classified as ignition protected are intended to be installed and used in accordance with the applicable requirements to the U. S. Coast Guard, the Fire Protection Standard for Pleasure and Commercial Motor Craft, ANSI/NFPA No. 302, and the American Boat and Yacht Council, Inc.

1.4 This test procedure does not cover ignition protection procedures for products or components that may operate in hydrogen and air mixtures.

1.5 This test procedure does not cover:

a) Mechanisms of ignition from external sources, such as static electricity, lightning, or other factors not related to the apparatus under test;

b) Apparatus based on the use of high voltage electrostatic principles;

c) The deterioration of external wiring; or

d) Connections installed in accordance with applicable installation standards.

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 required to maintain the level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard is not judged to comply with this Standard. Where appropriate, revision of requirements are 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 test procedure, the following definitions apply.

2.2 FLAMMABLE HYDROCARBON MIXTURE – A mixture of propane and air (percent by volume) between the ″Lower Explosive Limit″ (LEL) and ″Upper Explosive Limit″ (UEL) that will explode if ignited by any means. For purposes of this standard, mixtures of gasoline and air and diesel fuel and air between the LEL and UEL will be considered as hydrocarbon mixtures covered by the tests with propane and air.

2.3 HERMETICALLY SEALED – A void that is completely sealed by soldering, brazing, welding, fusion of glass, or the like, to prevent the entrance or escape of air or gas when changes in atmospheric pressure or ambient temperature, or both, occur.

2.4 IGNITION PROTECTED – A device or component 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 has insufficient electrical or heat 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 as applied to U.S. Coast Guard inspected vessels or as defined the the National Electrical Code 1996 Edition; Errata No. 1, ANSI/NFPA 70.

2.5 IGNITION SOURCE – Any electrical contacts, commutator or brush assembly, or collector ring and brushes that may produce electrical arcs of ignition capable energy; a resistor or other component that may operate at a temperature sufficient to ignite a flammable mixture; or two materials that may strike each other and produce a spark having sufficient energy to ignite a flammable mixture.

2.6 NONSPARKING – The condition resulting when moving parts of a device are unlikely to produce sparks of sufficient energy to ignite a flammable hydrocarbon mixture if the parts strike.

2.7 NORMAL OPERATING CONDITION – Any operating conditions of the device, including overload up to 400 percent (circuit breakers, switches, and the like) and a stalled rotor condition for any motor with the circuit protected by an overcurrent protective device specified by the product manufacturer.

3 General

3.1 A component or apparatus that is to be marked or designated as ignition protected shall not ignite a flammable hydrocarbon mixture when tested as specified in the following applicable requirements (see Figure 3.1):

a) An electrical device with any form of electrical contacts or other arcing source of ignition having sufficient energy to ignite a flammable hydrocarbon mixture is to be prepared as specified in Sections 6 and 7 and tested as specified in 8.1 – 8.5 and Ignition of Internal Goal Air Mixture, Section 9.

b) An electrical device with any form of heat producing component such as a resistor is to be prepared as specified in Sections 6 – 8 and tested as specified in 10.1.

c) An electrical device that is to be classified as ignition protected because it is incapable of releasing sufficient electrical energy to ignite a flammable hydrocarbon mixture is to be prepared and tested as specified in Electrical Energy Test, Section 11 using the test apparatus described in Electrical Energy Test Apparatus, Section 5.

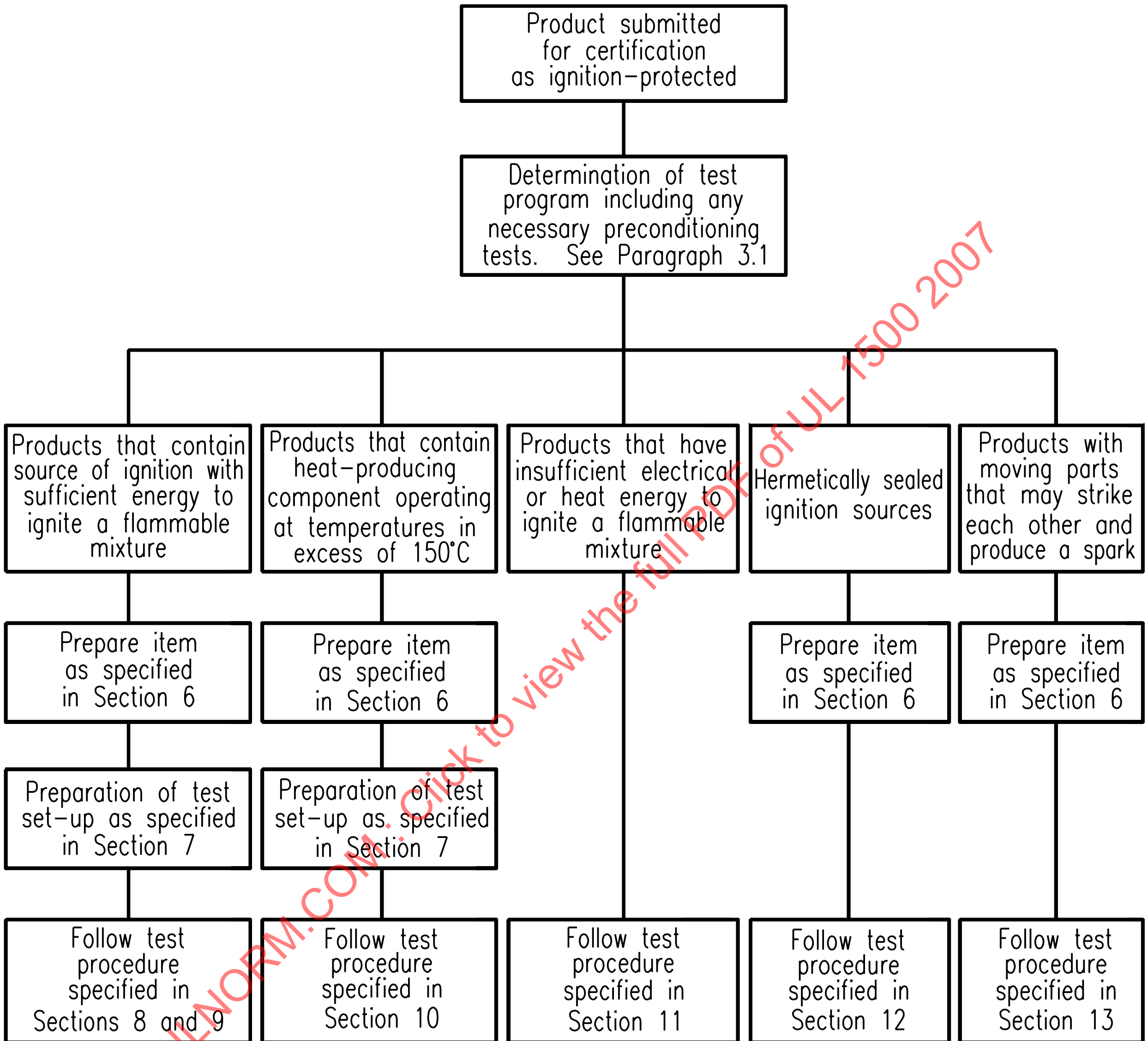
d) An electrical device that is to be classified as ignition protected because the potential ignition source is hermetically sealed shall comply with the requirements of 6.1 and 6.2 and the test procedures specified in Hermetically-Sealed Ignition Source, Section 12.

e) An electrical device that has moving parts, or a moving part and a stationary part, capable of striking each other with sufficient energy to create a spark capable of igniting a flammable hydrocarbon mixture shall comply with the requirements of 6.1 and 6.2 and the test procedures specified in Impact Sparks, Section 13.

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

Figure 3.1
Ignition test procedure flow chart

Figure 3.1 revised May 26, 1999



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4 Explosion Chamber

4.1 An explosion chamber is to be provided that is either constructed of transparent material or provided with viewing ports to permit visual observation of the test and test setup. See 8.5. The chamber is to be of sufficient size to enclose the device being tested and is to have means to relieve explosion pressures when the gas mixture in the chamber is ignited. The chamber is to be constructed so that all areas of the chamber will be purged of unburned gases and a homogeneous mixture will be created throughout the chamber.

4.2 Provision is to be made to feed a premixed charge of propane and air into the chamber at a rate of approximately 1 cubic foot (0.03 m^3) per minute. The flow is to be controlled by flowmeters in both the propane and air supply lines to obtain a 4.25 to 5.25 percent (by volume) of propane in air mixture. The propane and air are to be fed through a mixing chamber filled with glass beads, or a mixing chamber of equivalent construction to thoroughly mix the propane and air. The outlet connection of the mixing chamber is to be routed through a valve to the inlet of the explosion chamber so that all gas flow can be shut off immediately. See Figure 4.1.

4.3 A gas analyzer is to be provided to monitor the gas/air mixture in the explosion chamber and the mixture in the space containing the potential ignition source of the sample under test. The reading for the mixture in the chamber given by the gas analyzer is to correlate with the mixture determined by the gas flow rates when the chamber is fully purged of combustion products and air.

4.4 One vacuum pump is to be provided to evacuate and purge the void containing the potential ignition source of the test sample of air and burned gases and simultaneously draw the mixture from the explosion chamber into that void. A second vacuum pump is to be provided to sample the mixture in the chamber. The two vacuum pumps are to be connected through valves so that the mixture in either the void or the explosion chamber can be quickly determined to confirm the purging of the lines to the analyzer.

4.5 A high voltage source is to be provided to ignite the mixture in the void of the test sample. See 4.6. A high voltage arc may be produced by a miniature spark plug in the test sample or by the use of open contacts, depending on the device. The available voltage of the high voltage ignition source is to be approximately 15 kilovolts, although the voltage across the spark gap will vary depending on the gap distance.

4.6 An item under test, such as an ignition distributor, that contains a positive ignition source may use the integral ignition source for the test in accordance with 7.2.

4.7 The high voltage used to ignite the gas/air mixture in the test is to be of a type that simulates the conditions that exist in the equipment being tested. For test purposes, the following types of high voltage power supplies may be used:

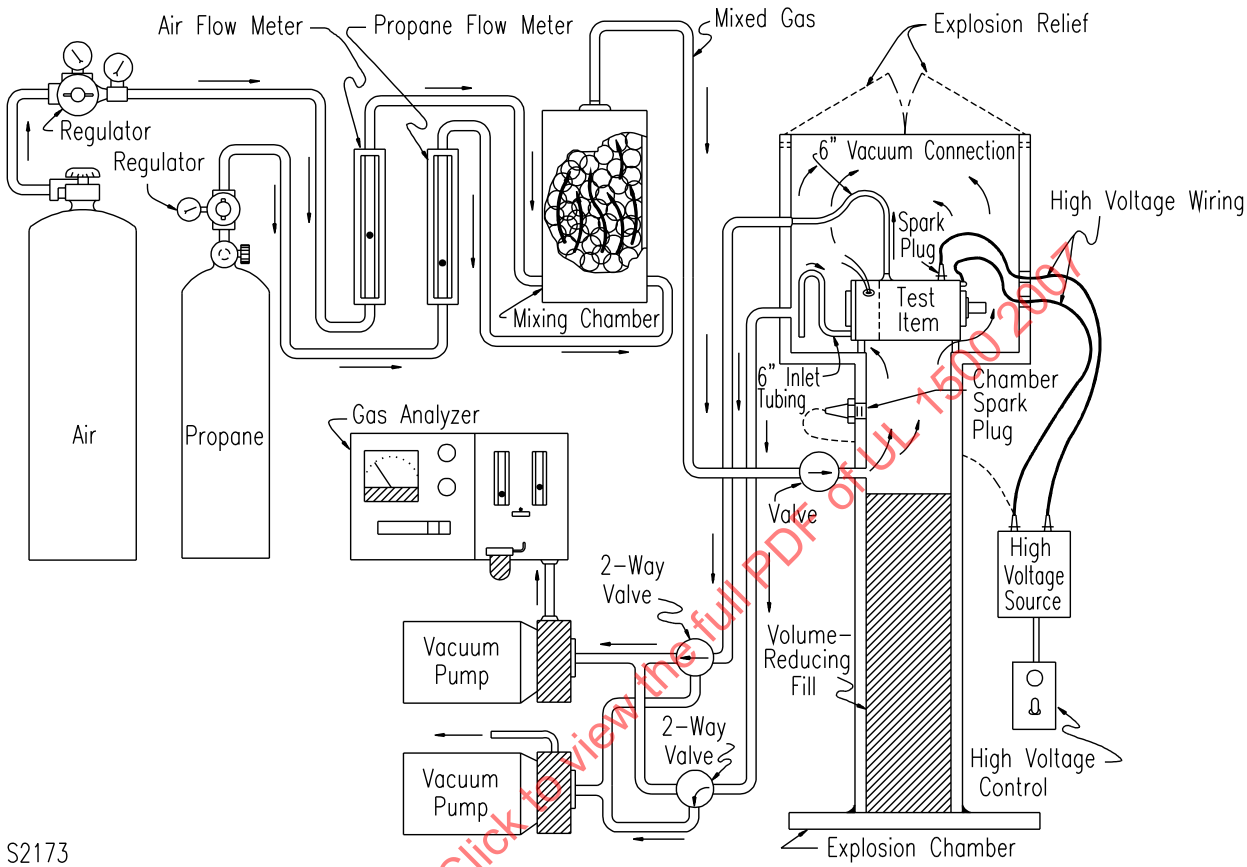
a) In the case of a switch, relay, circuit breaker, or other electrical device that opens or closes a circuit, the ignition source is to be of the type that produces a single short duration high voltage arc. The available voltage is to be at least 15 kilovolts. The high voltage source is to be fired once for each test firing.

b) If the item under test produces a continuous ignition source, such as brushes on a commutator or collector ring, the ignition source is to produce a continuous arcing across the contacts or spark plug. The available voltage is to be at least 15 kilovolts. The continuous high voltage source is to be energized for not less than 15 seconds for each test firing.

c) If the product has its own high voltage source of at least 15 kilovolts, such as in an engine ignition system, the intended ignition system may be used for the test. The high voltage source is to be energized for not less than 15 seconds for each test firing.

Figure 4.1
Ignition protection test set-up

Figure 4.1 revised May 26, 1999



5 Electrical Energy Test Apparatus

5.1 A circuit requiring spark ignition testing to determine whether it is incapable of causing ignition of a propane and air mixture under the conditions specified in Electrical Energy Test, Section 11, is to be tested using the circuit make and break apparatus described in 5.2 – 5.4. The circuit make and break apparatus is to be installed in an explosion chamber, such as described in 4.1 – 4.4.

5.2 The make and break mechanism is to consist of a 0.2 mm (0.08 inch) diameter tungsten contact wire, attached to the periphery of a rotating disc 50 mm (1.97 inches) in diameter. The disc is to rotate at a constant rate of 60 revolutions per minute and the contact wire is to make and break electrical contact with a copper alloy strip having an inside radius of 35 mm (1.38 inches). The copper alloy strip is to form a 180 degree arc and the contact wire is to be in contact with the strip for approximately one half of each revolution of the disc. See Figure 5.1.

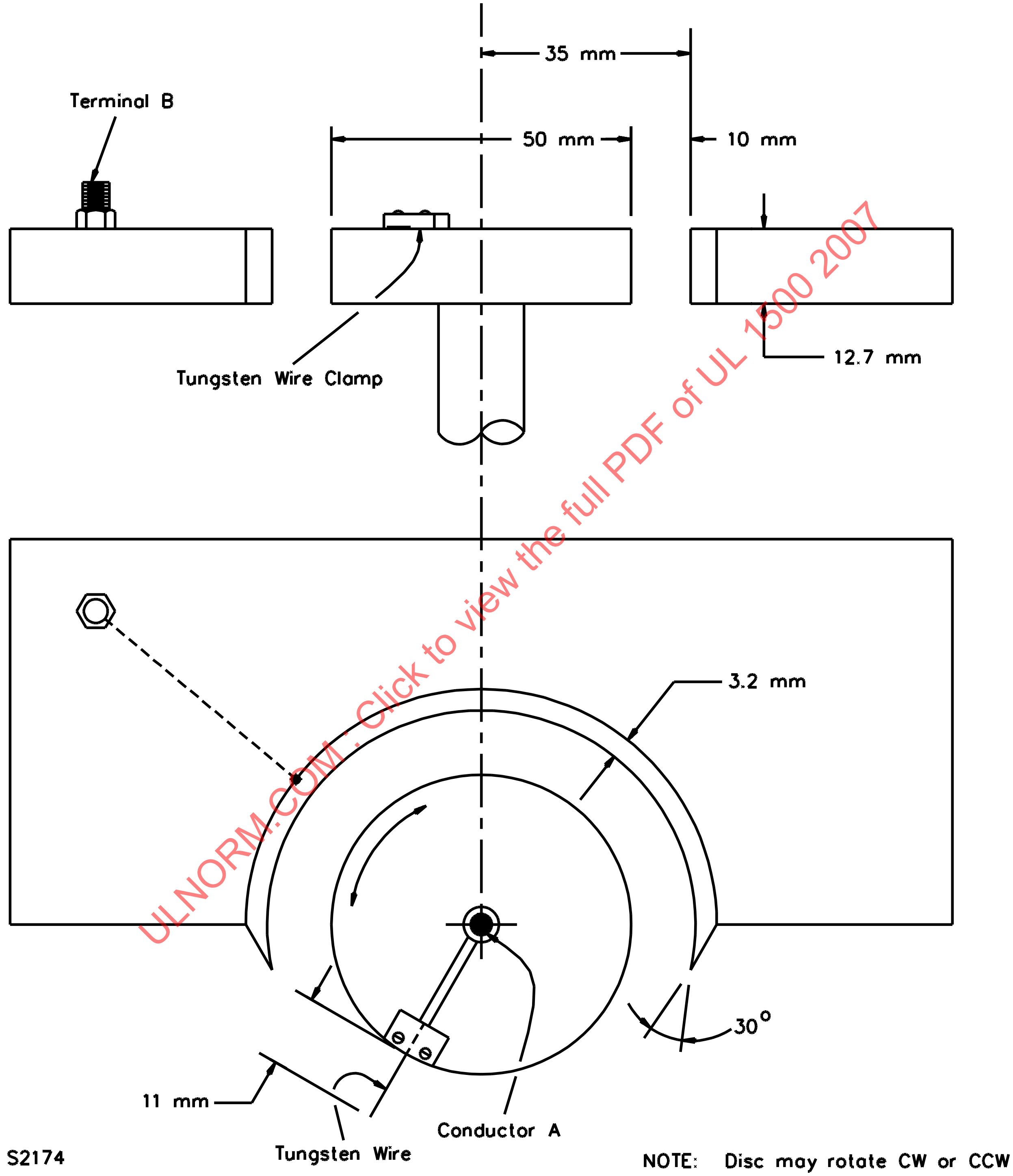
Exception: The rate of rotation of the disc may be changed or the contact momentarily stopped on the strip if the device under test requires more time to reach electrical saturation. See 11.3.

5.3 The contact wire disc and spindle is to be insulated from the drive mechanism, but provision is to be made to maintain continuity between the tungsten contact wire and conductor A (see Figure 5.1). The tungsten contact wire is to have a free length of 11 mm (0.43 inches) and is to be replaceable. Terminal B is to be connected to the semicircular contact strip and insulated from all other parts. The copper alloy strip is to be fabricated of a strip 12.7 ±1 by 3.2 ±0.5 millimeters with the ends tapered to a 30 degree angle as illustrated in Figure 5.1.

5.4 The circuit under test is to be connected between points A and B and the test conducted as specified in 11.1 – 11.4.

Figure 5.1
Electrical energy test apparatus

Figure 5.1 revised May 26, 1999



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6 Preconditioning

6.1 If possible, the same sample exposed to the conditioning tests specified for the particular standard for which the product is tested is to be subjected to the ignition protection tests. Among the factors to be taken into consideration when evaluating the acceptability of the ignition protected construction of a device are the following:

a) Corrosion Resistance – A metallic part of an ignition protected enclosure, including any flame screening, shall have sufficient corrosion resistance to reduce the likelihood of product malfunction in a marine environment.

b) Aging of Nonmetallic Materials – A nonmetallic component, including a rubber or neoprene grommet or seal, that forms part of an ignition protected enclosure shall be resistant to aging in a marine environment.

c) Chemical Resistance – An exposed nonmetallic component, including wire insulation, that may come in contact with oil, grease, or fuel shall be resistant to deterioration when exposed to Reference Fuel C and IRM 903 immersion oil (see Standard Test Method for Rubber Property – Effect of Liquids, ASTM D471-96).

d) Temperature Resistance – A nonmetallic component, including wiring or a grommet or gasket, shall be capable of operation within an ambient temperature range of minus 30°C (-22°F) to plus 60°C (140°F).

e) Physical Strength – The enclosure of an ignition protected component shall be constructed to resist abuses of intended service without distortion, collapse, loosening of parts, or other risk of defeat of the ignition protection feature.

f) Vibration and Shock Resistance – The device shall not malfunction due to vibration between 0 and 60 hertz and repeated shock impacts of 10 g (98 m/s^2) peak acceleration and 20 – 25 milliseconds duration.

6.2 Tests performed in evaluating the factors described in 6.1, and other physical and operational tests that may affect the ignition protection feature, are to precede the ignition protection tests.

6.3 If the construction of a device is such that production tolerances of the components will affect clearances between parts exposed to explosion pressures, the test samples used are to represent the maximum clearances involved.

7 Modification of Sample for Testing

7.1 Provision is to be made for evacuation and introduction of a flammable mixture into the void in which the ignition source is located as follows:

a) A copper tube of 0.061 ±0.007 inch (1.55 ±0.18 mm) inside diameter and not less than 6 inches (152 mm) long is to be installed so that the end of the tube opens to the void containing the ignition source. The tubing is to be formed into a coil or have at least two 90 degree bends to minimize pressure bleed off during the explosion. The tube may be attached by means of a threaded connection or by cement or solder so as to form a vapor tight connection. When installed in the explosion chamber, the tube is to be connected to a vacuum pump outside the chamber. See Figure 7.1.

Exception: If, because of the particular construction, it is not possible to use metallic copper tubing for the vacuum connection, a short length of rigid nonmetallic tubing may be used to separate the copper tubing from the device. The specified metal tubing is still to be used, however, to function as a flame arrester and to minimize the effect of any volume change on the test.

b) If the product does not contain gaps, flame arrester vent holes or other means that will permit gas to enter the void when the vacuum is applied, a second copper tube of 0.061 ±0.007 inch (1.55 ±0.18 mm) inside diameter and not less than 6 inches (152 mm) long is to be connected to the void as described in item A, including the coiling or 90 degree bends. When installed, the inlet end of the tubing is to be open to the explosion chamber so that the mixture drawn into the space containing the potential ignition source will be the same as the mixture in the explosion chamber. See Figure 7.1. The inlet and exhaust tubes are to be placed in the positions that most effectively purge the void of the unburned gases and fill the void with a homogeneous gas/air mixture.

c) Inlet tubing installed in accordance with (b) may be routed directly above a small container of water to serve as an indicator for internal explosions. See Figure 7.1. The magnitude of the internal explosions may also be monitored using a pressure transducer, accelerometer, or fine wire thermocouple. See 8.2.

Note: When the tubing is installed as illustrated in Figure 7.1, the pressure created by an internal explosion will cause a discernible ripple in the surface of the water.

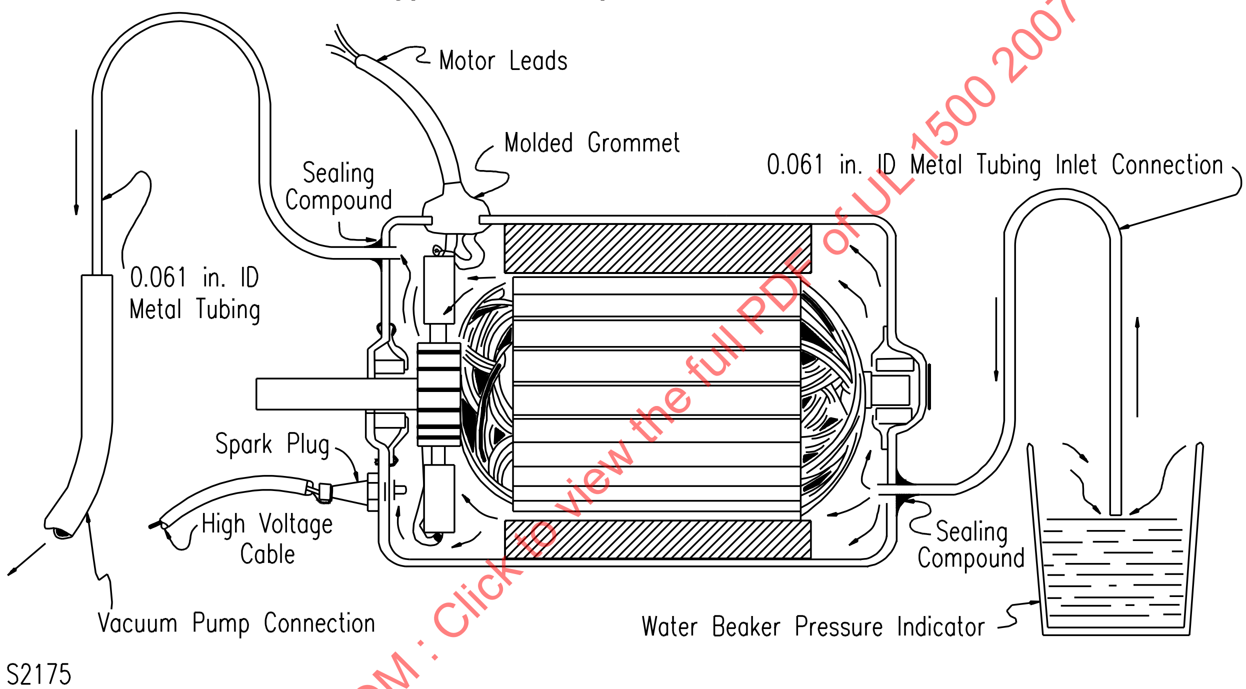
7.2 The device being tested is to be equipped with a positive source of ignition that may, in the case of an item such as a relay or ignition distributor, depend on operation of the device, or, in the case of an electric motor or other equipment where brushes may not arc sufficiently each time to cause ignition, on a separately installed spark plug activated by an external voltage source. To cause a positive arc in a high voltage distributor, the rotor is to be shortened by 0.12 ±0.02 inch (3.0 ±0.5 mm). In the case of a circuit breaker or switch, it may be possible to apply a high voltage arc across open contacts, provided the high voltage cannot cause any external arcing. See 7.5.

7.3 If the operation of the device causes physical changes or changes in clearances that could affect the ignition protection feature, provision shall be made to permit operation of the device in the explosion chamber. At least ten explosion tests are to be conducted in each operating condition.

7.4 The device or component is to be installed to simulate intended installation conditions if the method of installation would have any effect on the test. For example, machine screws are to be inserted in the mounting holes of a circuit breaker where the mounting holes pass through the housing and, if field wiring could affect the test, the device is to be wired in accordance with the manufacturer's instructions. The circuit is to be protected by an overcurrent protective device, of the type and size specified in the manufacturer's instructions.

7.5 Prior to the test, any covers or bands intended to permit field servicing of brushes or other similar purpose are to be removed and replaced, simulating intended field service.

Figure 7.1
Typical test set-up for small dc motor



8 Test Setup

8.1 With the device installed in the explosion chamber, the vacuum tube connection is to be connected with acceptable tubing (metallic or nonmetallic) to a vacuum pump outside the test chamber.

Exception: The vacuum connection is not required if the ignition source is a resistor or other component that operates at a temperature in excess of 150°C (302°F) and that is not enclosed.

8.2 If the inlet tube serves as a relative pressure indicator, the tubing is to be mounted directly above and perpendicular to the surface of a water container. Alternatively, a pressure transducer, piezoelectric accelerometer, or fine wire thermocouple may be connected to the device to indicate relative explosion pressures.

8.3 All high voltage wiring installed to create a positive internal arc is to be routed to avoid the possibility of any external arcing. Only high voltage wire that complies with or exceeds the requirements of the Standard for High Tension Ignition Cable, Standard September 1996, SAE J2031 is to be used for this purpose.

8.4 A device such as an ignition distributor or cranking motor that is to be operated in the chamber is to be operationally checked before gas is introduced into the chamber.

8.5 Prior to the introduction of the gas/air mixture into a device requiring a high voltage source, the high voltage ignition source to be used is to be activated with the chamber in total darkness to check for any evidence of external arcing. There is to be no evidence of arcing outside the device or at any of the chamber connections.

8.6 A device containing resistors or other heat sources capable of operating at temperatures in excess of 150°C (302°F) is to be installed with loads or conditions that will cause the components to operate at maximum temperature.

9 Ignition of Internal Gas/Air Mixture

9.1 The propane and air mixture is to be fed into the explosion chamber at a flow rate of approximately 1 cubic foot (0.03 m^3) per minute with the same volume of gas being vented from the chamber by the vacuum pumps. The propane/air mixture being fed into the chamber is to be maintained between 4.25 and 5.25 percent (by volume) of propane in air.

Note: The explosive limits for a propane and air mixture are approximately 2.2 percent by volume for the LEL and 9.5 percent by volume for the UEL.

9.2 A cover to provide explosion relief is to be placed over the explosion chamber. This cover is also to prevent any influx of outside air that may dilute the propane/air mixture and is to be arranged to prevent any build up of excess pressure inside the chamber.

9.3 The vacuum pump and gas analyzer are to be energized until the analyzer indicates that the mixture in the void of the test sample is between 4.25 and 5.25 percent (by volume) of propane in air. Alternatively, The propane gas-air mixtures are to be generated with a calibrated Mass Flow Controller feeding the individual gas and air components to a mixing chamber and in turn introducing into the sample under test and the test chamber until the air will be displaced. The inlet and outlet connections to the test sample and the test chamber are to be closed and the mixture within the test sample ignited by means of a spark plug connected to a high voltage source.

9.3 revised March 8, 2007

9.4 The vacuum pump and main gas flow control valve, or Mass Flow Controller to the chamber are to be turned off and the high voltage source activated as specified in 4.7 to ignite the mixture in the test sample void. When the high voltage source is activated, the pressure indicator is to be checked to verify that an explosion did occur within the sample. The relative intensity of the explosion is to be recorded. If no explosion is detected, that test is not to be counted and a determination is to be made as to why the mixture did not ignite. If the explosion results in continuous burning inside the void, the gas mixture control is to be left off until burning has ceased.

9.4 revised March 8, 2007