UL 122001

STANDARD FOR SAFETY

General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations

UL Standard for Safety for General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations, UL 122001

First Edition, Dated August 29, 2014

Summary of Topics

This revision of ANSI/UL 122001, is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

As noted in the Commitment for Amendments statement located on the back side of the title page, UL and ISA are committed to updating this co-designated standard jointly after processing according to the standards development procedures by UL.

The revisions are substantially in accordance with Proposal(s) on this subject dated December 14, 2018.

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ISA – The International Society of Automation
ISA-12.20.01-2009 (R2019)
First Edition

Underwriters Laboratories Inc.
UL 122001
First Edition

General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations

August 29, 2014

(Title Page Reprinted: February 14, 2019)

ANSI/UL 122001-2009 (R2019)

Commitment for Amendments

This Standard is issued jointly by ISA and Underwriters Laboratories Incorporated (UL). Comments or proposals for revisions on any part of the standard may be submitted to ISA and UL at any time. Revisions to this standard will be made only after processing according to the standards development procedures by UL. ISA and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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The most recent designation of ANSI/ISA-12.20.01 as a Reaffirmed American National Standard (ANSI) occurred on February 14, 2019.

This ANSI/UL Standard for Safety consists of the First Edition including revisions through February 14, 2019. The most recent designation of ANSI/UL 122001 as a Reaffirmed American National Standard (ANS) occurred on February 14, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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General Notes

This is the common ISA and UL Standard for the General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations. It is the first edition of ANSI/ISA-12.20.01 and the first edition of ANSI/UL 122001. The document is a modification of the ISA document to create the equivalent UL version and maintain the ANSI approval of this standard.

ANSI/ISA-12.20.01 and ANSI/UL 122001 contain identical requirements, and identical publication dates.

This common Standard was prepared by ISA – The International Society of Automation on May 4, 2009 but is now being maintained by Underwriters Laboratories (UL).

Note: Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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Preface ISA

This preface, as well as all footnotes and annexes, is included for information purposes and is not part of ANSI/ISA-12.20.01-2009 (R2019).

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1 Purpose

This standard is intended to enhance the safety of personnel by providing minimum requirements for electrical ignition systems for spark-ignited reciprocating internal combustion engines, parts of which are installed or operated in Class I, Division 2 or Zone 2 hazardous (classified) locations.

2 Scope

This standard provides minimum construction and test requirements in addition to manufacturer installation and maintenance recommendations for the safe operation of ignition systems and components for spark-ignited reciprocating internal combustion engines in Class I, Division 2, Group C or D or Class I, Zone 2, Group IIB or IIA, hazardous (classified) locations. These requirements apply to systems rated for normal operation with secondary voltages less than or equal to 35 kV.

This standard is intended to cover only ignition systems of reciprocating internal combustion engines that are stationary when in operation. This does not include any application where the engine would be in motion (vehicles) while operating. Applications addressed by the scope of this document include but are not limited to gas compressors, electric power generators, and pumps.

This standard applies to ignition systems suitable for use in an ambient temperature range of -40° C to +70°C (-40°F to +158°F).

3 References

ANSI NFPA 70, National Electrical Code®

ANSI/ISA 12.12.01, Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations

ANSI/ISA/UL 60079-0, Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations: General Requirements

ANSI/ISA/UL 60079-1, Electrical Apparatus for Use in Hazardous (Classified) Locations: Type of Protection – Flameproof “d”

ANSI/ISA/UL 60079-15, Electrical Apparatus for Use in Hazardous (Classified) Locations: Type of Protection “n”

ANSI/UL 1203, UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

ANSI/UL 2556, Wire and Cable Test Methods

SAE J2031, High Tension Ignition Cable

4 Definitions

4.1 alarm: an audible, visual, or physical presentation designed to alert the user that a specific parameter has been reached or exceeded.

4.2 ambient temperature: the temperature of the air in the immediate vicinity of the device, equipment or component.

4.3 approved: acceptable to the authority having jurisdiction (AHJ).

4.4 authority having jurisdiction (AHJ): the organization, office, or individual that has the responsibility and authority for approving equipment, installations, or procedures.

4.5 flashover: the occurrence of an arc or spark from the secondary distribution system at a point other than the spark gap.

4.6 clearances: shortest distance in air between two conductive parts.

4.6 creepage distance: shortest distance along the surface of a solid insulating material between two conductive parts.

4.7 ignition coil: a transformer used to convert primary voltage to secondary voltage intended to bridge a spark gap and initiate combustion.

4.8 ignition control unit: a component assembly that transforms energy from the ignition system power source and provides it to the primary distribution system in the required timing relationship to the engine.

4.9 ignition system: an electrical system designed to produce and distribute electrical energy to bridge a spark gap and initiate combustion.

4.10 installation drawing: a drawing or other document provided by the equipment manufacturer that details the allowed interconnections of ignition system components, indicates any special conditions of use, provides initial parameters if required, and provides the necessary information for operational use of the system or any component.

4.11 integral ignition coil: an ignition coil intended to be spark-plug mounted.

4.12 labeled: equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization, acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

4.13 listed: equipment or materials included in a list published by an organization, acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and by whose listing states that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.

4.14 maximum open circuit voltage: the maximum voltage produced by the ignition system with the secondary lead disconnected from the spark plug.

4.15 normal operating conditions: equipment is in normal operating conditions when it conforms electrically and mechanically with its design specifications, is connected as specified on applicable installation drawings, and is used within the limits specified by the manufacturer. This includes

a) supply voltage, current, and frequency;

b) environmental conditions;

c) minimum and maximum engine operating and cranking speeds;

d) all removable parts in place; and

e) all operator-accessible adjustments at their most unfavorable settings.

4.17 engine driven power source: any power source that relies on mechanical energy from the engine for conversion to ignition system electrical energy.

4.18 external power source: any power source that relies on energy from a source other than the engine for ignition system electrical energy.

4.19 primary distribution system: the components that deliver the primary voltage and current from the power supply and ignition control unit to the ignition coil, including the coil primary terminations.

4.20 primary lead assembly: an assembly of primary wires interconnecting the ignition coil with the balance of the primary distribution system.

4.21 primary wire: an insulated conductor interconnecting the ignition control unit and the ignition coil.

4.22 primary voltage: the voltage produced across the primary of the ignition coil under normal operating conditions.

4.23 primary wiring harness: a group of wires transporting voltage to the primary of the ignition coil.

4.24 raceway: an enclosure for routing, protecting, and supporting wires or cables.

4.25 rated: specified by the equipment manufacturer as the recommended maximum operating condition.

4.26 secondary distribution system: the component assembly that electrically interconnects the ignition coil and the spark gap, including the coil secondary terminations.

4.27 secondary lead or secondary wiring: a part of the secondary distribution system, either rigid or flexible, electrically interconnecting the coil and the spark plug.

4.28 secondary voltage: the voltage produced across the spark gap.

4.29 spark gap: the space between two conductors across which electrical energy is discharged.

4.30 spark plug: an electromechanical device that provides a spark gap intended to ignite a fuel mixture.

4.31 stationary: an installation that operates in a fixed location.

5 General requirements

Any portion of an ignition system installed in a Class I, Division 2 or Zone 2 hazardous (classified) location shall not, under normal operating conditions, produce arcs, sparks, or heat that could ignite a surrounding flammable atmosphere. This may be achieved through conformance with the construction requirements of Clause 6 and at least one of the protection methods indicated in 5.1, 5.2 or 5.3.

5.1 Spark containment: Any portion of the ignition system in the Class I, Division 2 or Zone 2 hazardous (classified) location is constructed such that arcs or sparks that could occur under normal operating conditions are contained in a manner that precludes ignition of a surrounding flammable atmosphere. See Clause 7 for requirements for spark containment.

5.2 Spark prevention: Any portion of the ignition system in the Class I, Division 2 or Zone 2 hazardous (classified) location is constructed such that arcs or sparks under normal operating conditions are prevented from occurring outside of the combustion chamber. See Clause 8 for requirements for spark prevention.

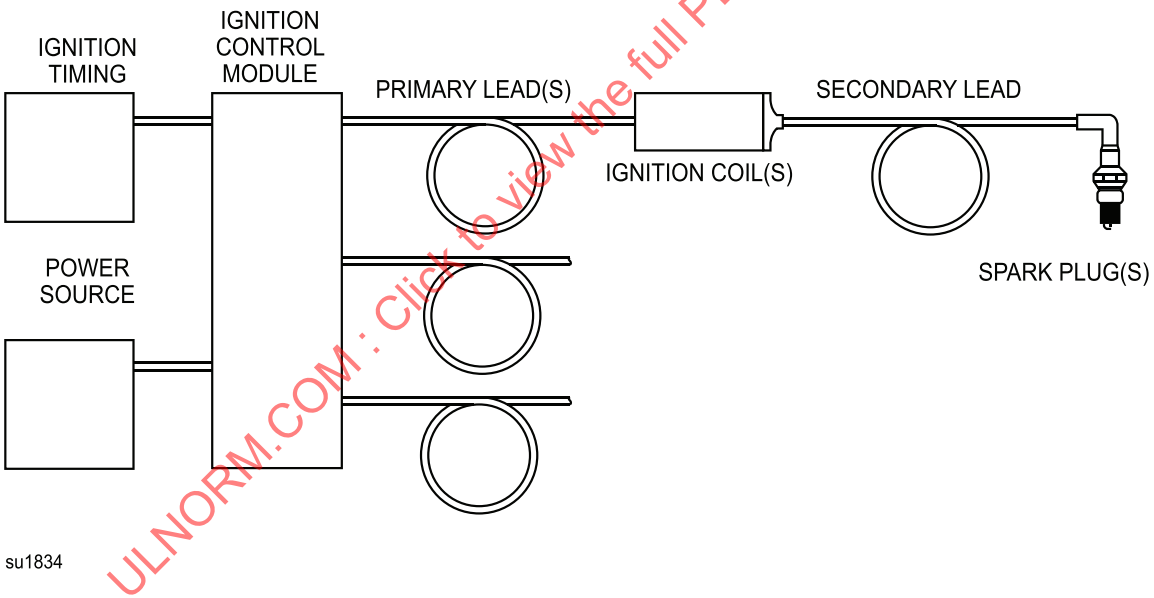
5.3 Spark detection/prevention: The ignition system is designed and constructed such that conditions leading to arcs or sparks in any portion of the ignition system outside of the combustion chamber are detected and remedied before such sparks occur. See Clause 9 for spark detection and prevention requirements.

Components of ignition systems are examined separately for conformance with the applicable requirements of this standard. In these cases, the installation drawing for the component shall detail the allowed interconnections with other equipment. The installation drawing may identify specific acceptable equipment or describe the critical characteristics of acceptable equipment. The installation drawing shall be sufficiently descriptive to enable the user to make fully informed equipment selections.

NOTE 1 – The parties assembling the completed ignition system are responsible for total system documentation and demonstrating conformance of the completed ignition system to this standard.

NOTE 2 – Components not marked as detailed in Clause 10 should not be installed in a hazardous (classified) location.

A typical ignition system with all of its components is illustrated in FIGURE 1.



NOTES:

1) THE ORDER AND ARRANGEMENT OF COMPONENTS IN AN IGNITION SYSTEM MAY BE DIFFERENT, ONLY BASIC IGNITION SYSTEM COMPONENTS ARE SHOWN IN THIS DIAGRAM.

2) GROUND CONDUCTORS MAY BE INSULATED CONDUCTORS OR PART OF A METALLIC FRAME.

FIGURE 1
COMPONENTS OF AN ELECTRICAL IGNITION SYSTEM

6 Construction and testing requirements

6.1 General

All electrical terminations in the Class I, Division 2 or Zone 2 hazardous (classified) location shall be secure against inadvertent disconnection. Terminations shall be constructed such that, when connected as specified on the installation drawing, a separating force specified in the pull test described in 11.11, is required for disconnection. Terminations shall also maintain continuity when subjected to the vibration test specified in 11.4. The vibration test shall be done directly after the completion of the pull test described in 11.11 without making any adjustments.

All primary wiring in the Class I, Division 2 or Zone 2 hazardous (classified) location shall be listed or labeled for at least the maximum voltage used. This wiring shall be enclosed in conduit or raceways suitable for the environment and application (i. e., vibration, temperature, high humidity, salt laden atmosphere, rain, snow, ultraviolet light, mechanical strength, etc.).

Ignition systems shall be constructed to withstand the temperatures to which they will be exposed in normal operation. The installation drawing shall specify the temperature for which the equipment is rated. Different temperature ratings may apply to separate portions of an ignition system.

Maximum surface temperature of all components of the ignition system shall be determined in accordance with the test procedures in 11.14 and marked on the device as specified in Clause 10.

Enclosures and insulating materials shall provide protection to prevent deterioration that could adversely affect the suitability of the equipment for use in Class I, Division 2 or Zone 2 hazardous (classified) locations. The list of compounds in Table 3 includes chemicals representative of those to which ignition systems would likely be exposed in normal operation.

All non-metallic enclosure materials, primary wires, primary lead assembly, or primary wiring harness, and insulation compounds associated with the ignition system utilized on the engine shall comply with the chemical compatibility tests of 11.3. All test chemicals in Table 3 shall be included in the test. One or more of the test chemicals may be omitted from the test if the installation drawing prepared in accordance with Clause 10 states that the equipment is not suitable for use in locations where the omitted test chemical is present. The manufacturer of the device shall make available information necessary to determine if critical materials of construction are compatible with substances not included in Table 3 that may be present in an installation area.

Ignition systems shall be constructed such that they are not damaged in a manner that could adversely affect the suitability of the equipment for use in Class I, Division 2 or Zone 2 hazardous (classified) locations by exposure to vibration levels they are likely to encounter in normal operation. The test in 11.4 demonstrates conformance with this requirement.

All components of the ignition system that will be installed in Class I, Division 2 or Zone 2 hazardous (classified) locations shall successfully demonstrate compliance with the impact test requirements in 11.15. Specific components fabricated from ceramic or other similar materials may be supplied with a cover or shroud that will be included with the system and shall be in place for the impact test.

6.2 Power sources

Ignition systems shall operate properly at ± 25% of the rated input voltage of the ignition control unit for DC power sources or ± 10% of the rated input voltage of the ignition control unit for AC power sources from an external power source.

Engine driven power source requirements (if required) shall be indicated on the installation drawing.

6.3 Ignition control unit

The primary voltage output from the ignition control unit, when connected to equipment specified on the installation drawing, shall not exceed the rated primary voltage by more than 25% when supplied with the ignition control unit's rated power supply, including tolerance.

The installation drawing for an ignition control unit shall specify the power-supply voltage, input voltage, primary voltage output, and temperature for which the ignition control unit is rated and the equipment to which the ignition control unit may be connected.

The ignition control unit (including all internal components and circuitry) intended for installation in Class I, Division 2 or Zone 2 locations shall be listed for the intended location. If not, then the installation drawing shall indicate the ignition control unit must be installed in an unclassified location.

6.4 Primary wires

Primary wire insulation shall be listed or labeled for the temperature to which the wires will be exposed in normal operation, with a minimum rating of 105°C.

The installation drawing illustrating the primary wires, primary lead assembly, or primary wiring harness shall specify the ratings of the voltage and temperature of the primary wires and the equipment to which the primary wires, primary lead assembly, or primary wiring harness may be connected.

6.5 Ignition coils

The normal operating secondary voltage of an ignition coil (or integral ignition coil) shall be 35 kV or less. The maximum open circuit voltage is not limited to 35kV.

An ignition coil (or integral ignition coil) shall not exhibit external flashover when connected to the secondary distribution system equipment on the installation drawing as detailed in 5.3. It shall be subjected to the flashover test as outlined in 11.7.

The installation drawing for an ignition coil (or integral ignition coil) shall specify the temperature ratings for the coil and the equipment to which the ignition coil may be connected. The ignition coil shall be subjected to the elevated temperature test described in 11.2.3.

6.6 Secondary leads

Ignition cable used in secondary leads shall meet the requirements of SAE J2031, High Tension Ignition Cable. The minimum secondary lead wire size shall be 7 mm. The temperatures used in the elevated temperature tests detailed in 11.2.2 shall be less than the temperature rating of the secondary lead.

Secondary leads shall be constructed such that, under normal operating conditions, there will be minimum breakdown of insulation due to abrasion. The tests in 11.1 shall be used to demonstrate conformance of flexible secondary leads with this requirement. These tests are not required for metal-sheathed secondary leads if the metal sheath has a minimum thickness of 0.1 mm.

Secondary leads (including extension and non-flexible section of the lead) shall be constructed to withstand the temperatures to which they will be exposed in normal operation. The test in 11.2.2 shall be used to demonstrate conformance with this requirement.

Flexible secondary leads shall be subjected to the pull test outlined in 11.16.

Flexible secondary leads shall provide protection to prevent deterioration that could adversely affect the suitability of the equipment for use in Class I, Division 2 or Zone 2 hazardous (classified) locations. The tests outlined in 11.3 include chemical compounds representative of those to which secondary leads would likely be exposed in normal operation. All flexible secondary leads ~~utilized on skid~~ shall demonstrate compatibility with all compounds in Table 3. One or more of the chemicals may be omitted from the compatibility listing if the installation drawing states that the equipment is not suitable for use with the omitted chemical compound. The manufacturer of the device shall make available information necessary to determine if critical materials of construction are compatible with substances not included in Table 3 that may be present in the specific installation area.

After the secondary lead is tested with the specific compound as detailed in 11.3, the same sample shall be subjected to the lead bending tests outlined in 11.7 and then the secondary lead dielectric voltage withstand tests detailed in 11.9.

All flexible ignition cable secondary leads exposed to any outdoors condition shall be tested for suitability and resistance to UV degradation as required in 11.8. Any secondary lead not qualified under the requirements of 11.8 shall be labeled not suitable for outdoor installations. This test is not required for metal-sheathed secondary leads if the metal sheath has a minimal thickness of 0.1 mm.

The installation drawing for secondary leads shall specify the temperature ratings for the leads and the equipment on the installation drawing as detailed in 5.3. All secondary lead assemblies shall be subjected to the temperature tests outlined in 11.2.

Any secondary lead or wire that is not metal enclosed or shielded using a grounded metallic braid must be subjected to and meet the requirements outlined in the secondary lead and wiring cut test detailed in 11.13.

6.7 Spark plugs

Spark plugs that do not conform to the requirements of 7.3 shall withstand the spark plug dielectric test as detailed in 11.12 and the flashover test in 11.7. This test sample shall include any applicable plug extension device and any non-flexible portion of the secondary lead that is connected to the spark plug.

The installation drawing for spark plugs shall specify the maximum temperature for which the spark plugs are rated, the required torque values, maximum gap setting, and specific gaskets for proper installation. The instructions must include directions for use of an engine spark plug thread port “Go-No-Go” gauge that will indicate if the port is compatible with the specific spark plug. If the result of the thread gauge operation is unsatisfactory then the installation should be considered as not suitable for hazardous (classified) locations.

The spark plug assembly shall be subjected to a pressure and high temperature test as detailed in 11.6.

7 Spark containment

7.1 General

Ignition system components are considered to satisfy the requirements of 5.1 if they meet the applicable requirements of Clause 6 and the additional requirements of this Clause. All equipment associated with the secondary system shall be tested in accordance with 11.5.

7.2 Secondary leads

Secondary leads are considered to satisfy the requirements of 5.1 if they are constructed such that:

1) The conductors are enclosed in an effectively grounded sheathing material capable of shunting flashover to ground and shall meet the requirements of one of the following:

a) Any free volume between the conductor insulation and the sheathing is effectively sealed against entry of a surrounding flammable atmosphere per the sealed device requirements of ANSI/ISA 12.12.01.

b) All shielded secondary leads including terminations shall pass the tests outlined in 11.5.

– For Groups C or D, the joints shall comply with the applicable construction requirements of ANSI/UL 1203.

– For Group IIA or IIB, the joints shall comply with the applicable construction requirements of ANSI/ISA/UL 60079-0 and ANSI/ISA/UL 60079-1 for flameproof “d”.

7.3 Spark plugs

Spark plugs are considered to satisfy the requirements of 5.1 if they are constructed such that

1) The spark plug insulator external to the combustion chamber is enclosed in an effectively grounded sheathing material capable of shunting flashover to ground and shall meet all of the requirements of the following:

a) Any free volume between the conductor insulation and the sheathing is effectively sealed against entry of a surrounding flammable atmosphere per the sealed device requirements of ANSI/ISA 12.12.01.

b) All spark plug assemblies shall pass the tests outlined in 11.5.

– For Groups C or D, the joints shall comply with the applicable construction requirements of ANSI/UL 1203.

– For Group IIA or IIB, the joints shall comply with the applicable construction requirements of ANSI/ISA/UL 60079-0 and ANSI/ISA/UL 60079-1 for flameproof “d”.

c) The portion of the spark plug that is contained inside the engine combustion chamber is excluded from the test outlined in 11.5.

7.4 Terminations

Terminations in the secondary distribution system are considered to satisfy the requirements of 5.1 if they are constructed such that, when secondary-distribution-system equipment is connected as specified on its installation drawing:

1) The terminations will not exhibit flashover during the flashover test outlined in 11.7, and

2) Live parts of the terminations are sealed per the sealed device requirements of ANSI/ISA 12.12.01.

8 Spark prevention

8.1 General

Ignition-system components are considered to satisfy the requirements of 5.2 if they meet the requirements of Clause 6 and the additional requirements of this Clause.

8.2 Terminations

Terminations in the secondary distribution system are considered to satisfy the requirements of 5.2 if they are constructed such that, when secondary distribution system equipment is interconnected as specified on its installation drawing;

1) the complete ignition system, including all primary and secondary components that may be installed in a hazardous location, shall pass the spark prevention test outlined in 11.10;

2) the complete ignition system will not exhibit flashover during the flashover test outlined in 11.7; and

3) live parts of the terminations, as well as the surfaces relied upon to provide the creepage distances and clearances required to prevent flashover are sealed per the sealed device requirements of ANSI/ISA 12.12.01.

9 Spark detection/prevention

Equipment designed to satisfy the requirements of 5.3 shall be capable of detection of conditions leading to arcs or sparks and to prevent their occurrence.

The design of such equipment shall be the subject of special investigation to determine its effectiveness for the purpose.

Methods to accomplish the purpose may include, but are not limited to the following:

1) Monitor secondary voltage and alarm

2) Detect ignition firing characteristic outside expected parameters

3) Monitor power cylinder expected output

4) Monitor power cylinder pressure

5) Monitor for inappropriate detonation

10 Documentation and marking

The equipment shall be marked with the following minimum information:

a. the name of the manufacturer or his registered trade mark;

b. the manufacturer's type identification;

c. a serial number

d. reference to installation drawing

e. Input electrical ratings

f. Hazardous location suitability: Class I, Division 2, and Group C or D or Class I, Zone 2, and Group IIA or IIB. In lieu of Group(s), a specific gas or vapor may be marked.

g. Temperature class marking according to 10.1

h. Any other markings or cautions necessary for the installation and safe operation of the equipment

i. The international symbol may be used to refer the operator to an explanation in the equipment instructions.

On small components where there is limited space, a reduction in the marking is permitted. The following lists the minimum marking that is required on the component:

a) the name or registered trademark of the manufacturer;

b) the manufacturer's type identification.

c) Hazardous location suitability: Class I, Division 2, and Group C or D or Class I, Zone 2, and Group IIA or IIB. In lieu of Group(s), a specific gas or vapor may be marked. The following abbreviations shall be permitted – CL = Class, DIV = Division, ZN = Zone, GP = Group

d) Temperature marking according to 10.1

Connectors, fuseholders, and lampholders shall be marked with the following or a technically equivalent warning:

WARNING: DO NOT REMOVE OR REPLACE WHILE CIRCUIT IS LIVE UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITIBLE CONCENTRATIONS OF FLAMMABLE GASES OR VAPORS.

If practical, this marking shall be either on or adjacent to the component. Otherwise, this marking shall be displayed on a prominent place on the enclosure.

10.1 Surface temperature marking requirements

The maximum temperature of any surface that may come in contact with a flammable gas or vapor in air mixture shall be determined as detailed in 11.14 and marked with the appropriate temperature class as illustrated in Table 1.

Table 1
Temperature class

Maximum Surface Temperature		Temperature Class	
°C	°F	Class I, Division 2	Class I, Zone 2
450	842	T1	T1
300	572	T2	T2
280	536	T2A	
260	500	T2B	
230	446	T2C	
215	419	T2D	
200	392	T3	T3
180	356	T3A	
165	329	T3B	
160	320	T3C	
135	275	T4	T4
120	248	T4A	
100	212	T5	T5
85	185	T6	T6

10.2 Manufacturer's instructional manual

10.2.1 The manufacturer's instructional material shall include, in addition to the information required for ordinary locations, the information shown in 10.2.2 through 10.2.5 to emphasize the precautions required when operating the equipment in a Division 2 or Zone 2 location.

10.2.2 The following or equivalent specification for the location of the equipment shall be included:

This apparatus is suitable for use in Class I, Division 2 or Zone 2 groups (as applicable), or unclassified locations.

10.2.3 The following or equivalent information for use of the equipment shall be included.

The installation drawing shall provide information for proper connection and installation.

10.2.4 If equipment contains sealed components the following shall be provided:

A warning such as: "WARNING: EXPOSURE TO SOME CHEMICALS MAY DEGRADE THE SEALING PROPERTIES OF MATERIALS USED IN THE FOLLOWING DEVICES"; identification of the sealed devices

The list of materials used in the construction of these devices.

Name of sealed device – generic name of the material and the supplier's name and type designation.

A recommendation for the user to periodically inspect the devices named above for any degradation of properties and replace if degradation is found.

10.2.5 The following warning or equivalent warnings for repair of the equipment shall be included:

If replacement of a component (e.g., fuse, lamp or plug-in module) could ignite the flammable atmosphere

WARNING: EXPLOSION HAZARD. DO NOT REMOVE OR REPLACE LAMPS, FUSES OR PLUG-IN MODULES (AS APPLICABLE) UNLESS POWER HAS BEEN DISCONNECTED OR THE AREA IS KNOWN TO BE FREE OF IGNITIBLE CONCENTRATIONS OF FLAMMABLE GASES OR VAPORS.

If disconnecting the equipment supply could ignite the flammable atmosphere

WARNING: EXPLOSION HAZARD. DO NOT DISCONNECT WHILE THE CIRCUIT IS LIVE OR UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITIBLE CONCENTRATIONS OF FLAMMABLE GASES OR VAPORS.

If components are relied upon to make the equipment suitable for Division 2 or Zone 2 locations, these components shall be individually identified. The following is an example of identifying such components:

WARNING: SUBSTITUTION OF THE FOLLOWING COMPONENTS MAY IMPAIR SUITABILITY FOR DIVISION 2:

1. Sealed relays

2. Sealed pushbuttons

10.2. The ignition system manufacturer shall prepare and make available information detailing how the ignition system is to be installed and maintained. This information shall include the following as a minimum:

1) Installation instructions and installation drawings

2) A commissioning checklist that shall include at least the following:

a) Cylinder spark-plug port threads cleaned

b) Cylinder spark-plug port seating area cleaned

c) Cylinder spark-plug port threads gauged to engine manufacturer's specification

d) Spark plug gap verified to engine manufacturer's specification

e) Spark plugs torqued to manufacturer's specification

f) Spark-plug insulator and mating boot cleaned (including a note as to not use shop rags with residual coatings)

g) Secondary leads (if applicable) routed and supported away from metal surfaces. Two inches or more is recommended. It is recommended that the secondary lead length should not exceed 24 inches.

h) All components mounted in areas that will not exceed their temperature rating

i) Components securely mounted and effectively grounded with guidance provided from the manufacturer's instructions and installation drawings and as required in SAE J1908

j) Continuity check complete for all wiring, all terminations secure and torqued to manufacturer's specification

k) Covers in place and secure

l) Raceway fittings properly engaged

m) Verification of proper engine ignition timing prior to engine starting

3) Regular maintenance recommendations that shall include at least the following:

a) Visual inspection for buildup of contaminants that could degrade insulation and cause premature flashover

b) Visual inspection for security of component mounting, terminations, covers, and fittings

c) Periodic voltage checks of primary and secondary distribution systems

d) Inspections and tests for indications of misfire, including

1) sound of the engine for detonation;

2) sound of the engine for rough running;

3) cylinder exhaust temperature measurement;

4) throttle valve position;

5) vacuum gauge reading;

6) fuel consumption;

7) emissions analysis; and

8) vibration analysis.

e) Replacement schedule for critical components including secondary leads

4) Information regarding conditions that could lead to uncontained flashover, other arcs or sparks or hot surfaces that should be corrected immediately.

11 Test procedures

The information in Table 2 should be reviewed to properly determine which testing requirements apply to the specific ignition system protection method.

Table 2
List of performance tests

Ignition System Testing Requirement	Spark Containment	Spark Prevention	Spark Detection/ Prevention
Abrasion wheel test for secondary leads or wiring – 11.1.1		X	X
Emery cloth abrasion test – 11.1.2		X	X
Flexible secondary lead elevated temperature exposure test – 11.2.1		X	X
Extension or non-flexible section secondary lead elevated temperature exposure test – 11.2.2	X	X	X
Ignition coil elevated temperature exposure test – 11.2.3	X	X	X
Chemical compatibility with oil – 11.3.1	X	X	X
Chemical compatibility with fuel – 11.3.2 – see note 1	X	X	X
Chemical compatibility with saltwater – 11.3.3 – see note 1	X	X	X
Vibration test – 11.4	X	X	X
Shielded secondary system tests – 11.5	X		
Spark plug pressure and temperature tests – 11.6	X	X	X
Secondary lead assembly flashover tests – 11.7	X	X	X
Secondary lead UV degradation tests – 11.8 – see note 1		X	X
Secondary lead bending and dielectric voltage withstand tests – 11.9		X	X
Spark prevention test – 11.10		X	X
Primary and secondary terminations pull test – 11.11	X	X	X
Spark plug dielectric test – 11.12		X	X
Secondary lead or wiring insulation cut test – 11.13		X	X
Surface temperature test – 11.14	X	X	X
Impact test – 11.15	X	X	X
Secondary lead pull test – 11.16		X	X

NOTE 1 – The indicated test may not be applicable in all applications (i.e. flexible secondary leads not exposed to outdoor conditions do not require the UV test in 11.8)

NOTE 2 – The “X” indicates that the specific test applies to the protection method.

11.1 Abrasion test for secondary leads or wiring

All flexible secondary leads and wiring assemblies shall be subjected to testing methods in 11.1.1 and 11.1.2 to be suitable for use in hazardous locations. Separate samples are submitted for each test.

11.1.1 Abrasive wheel test

The test specimen shall consist of two samples of finished insulated wire assemblies. Each sample shall be 76 cm (30 in.) in length, minimum.

An example of the test apparatus is shown in Figure 2. The main body of the test apparatus is comprised of twelve 12.7 X 12.7 X 165.1 mm (0.5 X 0.5 X 6.5 inch) square bars equally spaced around the circumference. Each square bar must have a working edge that is equivalent to a grade C2 carbide steel. Each bar should be located in parallel to the adjacent bars with no unbroken edges with the dimensions given in Figure 2.

Two previously untested samples shall be mounted securely at one end and weights freely suspended to the other end with the wire assembly placed over a squirrel cage abrasion tester as shown in Figure 2. The weights shall be 1 kg (2.2 lb) for cables up to 1.37 cm (0.54 in.) in diameter, 1.5 kg (3.3 lb) for cables 1.37 cm (0.54 in.) to 2.16 cm (0.85 in.) in diameter, and 3 kg (7 lb) for cables 2.16 cm (0.85 in.) to 4.6 cm (1.82 in.) in diameter. The specimen shall be subjected to 500 oscillations at 20 ± 2 oscillations per minute. An oscillation shall consist of 5 bars travel forward and backward from a given point.

All abrasion wheel tests should be performed at 50°C ± 2°C.

At the conclusion of the test, the wire assemblies shall be considered to have passed the test if there is no breakdown of insulation of either specimen when subjected to the secondary lead dielectric voltage withstand tests as detailed in 11.9.

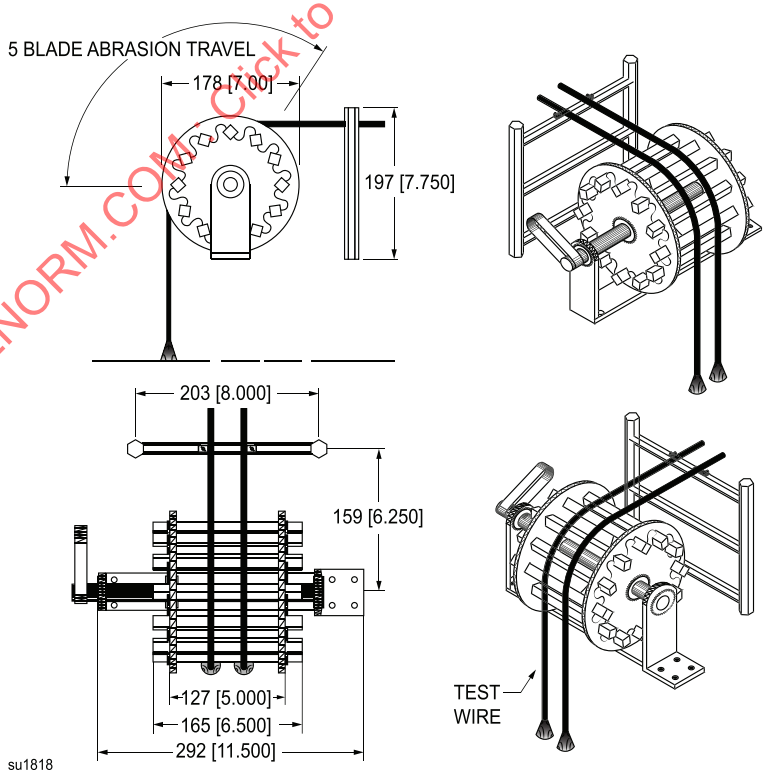


Figure 2
Abrasive wheel test apparatus

11.1.2 Emery cloth abrasion test

Six previously untested straight specimens of the wire assembly 1000 mm (40 inches) long are to be tested without any conditioning. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of 25.0 ± 5.0°C (77.0 ± 9.0°F) throughout the test.

One end of each specimen is to be attached to a horizontal, reciprocating table while the table is at one end of its travel. The other end of each specimen is to be attached to a weight that exerts 3.3 ± 0.1 N or 340 ± 13 gf (12.0 ± 0.5 ozf). Each specimen is to be laid over a stationary quarter cylinder to whose outer surface an unused sheet of Grade 1/2 (medium) emery cloth is attached. The radius of the surface of the emery cloth is to be cloth is to be 90 mm ± 6 mm (3.5 inches ± 0.25 inch). The longitudinal axis of the cylinder is to be horizontal and perpendicular to each of the vertical planes that contain the specimens as they move on and are abraded by the emery cloth. The top edge of the cylinder is to be located approximately even with the surface of the table.

The table is to be started in its horizontal reciprocating motion (simple harmonic motion) at the rate of 28 cycles per minute, each cycle consisting of one complete back-and-forth motion with a stroke of 160 mm (6-1/4 inches). The table is to be stopped every 50 cycles and the emery cloth is to be shifted slightly to one side so that in subsequent cycles each specimen is abraded by a fresh surface of the cloth. Each of the six wire assemblies will be tested for a minimum of 800 cycles.

At the conclusion of the test, the wire assemblies shall be considered to have passed the test if there is no breakdown of insulation of any specimen when subjected to the secondary lead dielectric voltage withstand tests as detailed in 11.9. An example of the test device and arrangement is illustrated in Figure 3.

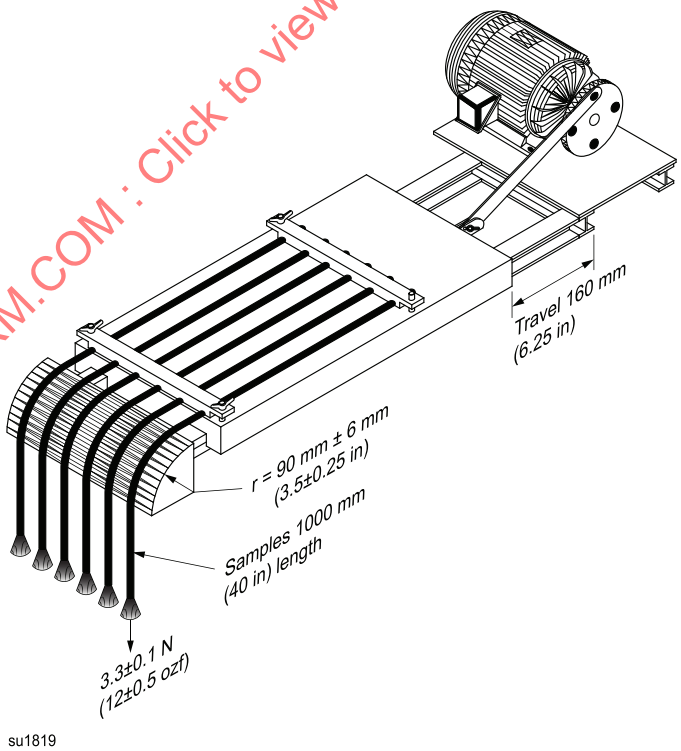


Figure 3
Emery cloth abrasion test apparatus

11.2 Elevated temperature exposure test

11.2.1 Flexible secondary lead elevated temperature exposure test

A sample of the secondary lead assembly shall be conditioned by being placed in an air oven. The air contained in the oven shall be completely changed at least 8 times but not more than 20 times per hour. The oven shall be heated to, and maintained at, a temperature of 25° C ± 5° C (77° F ± 9° F) above the maximum rated temperature declared by the manufacturer of the component assembly, for a period of 14 days. This test shall be conducted at a temperature no less than 65°C(149°F).

The sample, after it has been removed from the air oven and cooled to room temperature, shall have no visible cracks or other deterioration that could adversely affect the suitability of the equipment for use in Class I, Division 2 or Zone 2 hazardous (classified) locations when examined with normal vision.

Following this test, the sample will be subjected to the secondary lead bending and dielectric voltage withstand tests as outlined in 11.9.

11.2.2 Extension or non-flexible section secondary lead elevated temperature exposure test

A sample of the secondary extension or non-flexible section shall be conditioned by being placed in an air oven. The air contained in the oven shall be completely changed at least 8 times but not more than 20 times per hour. The oven shall be heated to, and maintained at, a temperature of 25°C ± 5°C (77°F ± 9°F) above the maximum rated temperature declared by the manufacturer of the component assembly, for a period of 14 days. This test shall be conducted at a temperature no less than 200°C (392°F).

The sample, after it has been removed from the air oven and cooled to room temperature, shall have no visible cracks or other deterioration that could adversely affect the suitability of the equipment for use in Class I, Division 2 or Zone 2 hazardous (classified) locations when examined with normal vision.

Next, the sample shall be subjected to the spark plug dielectric test, 11.12. The appropriate spark plug will next be inserted into the sample and the sample shall withstand the immediate application of 35 kV DC for 5 minutes without dielectric breakdown of the insulation.

11.2.3 Ignition coil elevated temperature exposure test

A sample of the ignition coil (or integral coil) assembly shall be conditioned by being placed in an air oven. The air contained in the oven shall be completely changed at least 8 times but not more than 20 times per hour. The oven shall be heated to, and maintained at, a temperature of 25°C ± 5°C (77°F ± 9°F) above the maximum rated temperature declared by the manufacturer of the component assembly, for a period of 14 days. This test shall be conducted at a temperature no less than 55°C(131°F).

The sample, after it has been removed from the air oven and cooled to room temperature, shall have no visible cracks or other deterioration that could adversely affect the suitability of the equipment for use in Class I, Division 2 or Zone 2 hazardous (classified) locations when examined with normal vision.

The sample will next be subjected to the flashover test as outlined in 11.7

11.3 Chemical compatibility

All non-metallic enclosure materials, primary wires, primary lead assembly, or primary wiring harness, and insulation compounds shall be tested for compatibility with the chemical compounds listed in Table 3. The specific details of the requirements are defined in 11.3.1, 11.3.2, and 11.3.3 below.

All secondary lead assemblies shall also be investigated for chemical compatibility but at the conclusion of each test for the secondary lead assembly, the specimen shall be subjected to the secondary lead bending and dielectric voltage withstand tests detailed in 11.9.

11.3.1 Chemical compatibility with oil

Measure the diameter of a specimen, approximately 400 mm (15.8 inches) in length, and then immerse for 96 hours in the specific oil as indicated in Table 3 below at a temperature of 100°C ± 1°C (212°F ±1.8°F) with the specimen ends emerging approximately 50 mm (2 inches) above the surface of the oil (the oil shall be stirred during the test). Remove the specimen, wipe off the excess oil, and cool to room temperature. The diameter of the test specimen shall not have increased by more than 15% nor decreased by more than 5%.

11.3.2 Chemical compatibility with fuel

Measure the diameter of a specimen, approximately 400 mm in length, and then immerse in the specific fuel as indicated in Table 3 at 23° C ±1° C (73.4° F ±1.8° F) for 30 days with cable ends emerging approximately 100 mm above the surface of the fuel. Remove the sample and allow to dry for approximately 30 minutes. The diameter of the test specimen shall not have increased by more than 15% nor decreased by more than 5%.

11.3.3 Chemical compatibility with saltwater

Measure the diameter of a specimen, approximately 400 mm in length, and then place the test specimen in a full draft, circulating-air oven maintained at 90°C ± 2°C for 4 hours and then immediately immerse in a salt solution (3% mm of NaCl in water) and maintain at 50°C ± 2°C for 24 hours. Remove the specimen from the solution and drain for 30 minutes at room temperature. The diameter of the test specimen shall not have increased by more than 15% nor decreased by more than 5%.

Table 3
Chemical compatibility

Test Chemical	Specification	Qualification Test
Salt*	3% m/m NaCl in water	Saltwater
Oil*	ASTM No.1	Oil
Oil	ASTM D-471 No.2	Oil
Oil	ASTM D-471 No.3	Oil
Fuel*	ASTM Fuel C	Fuel
Ethylene Glycol	Antifreeze component	Oil
Diethylene Glycol	Antifreeze component	Oil
Propylene Glycol	Antifreeze component	Oil
Synthetic Oil	Synthetic lubricating oils manufactured from polyalphaolefin (PAO) base stocks.	Oil
Penetrating Oil	Aliphatic Petroleum Distillates	Fuel
Degreaser	Aliphatic Petroleum Distillates with 5% max. 2-Butoxyethanol	Oil
Solvent	Aliphatic Petroleum Distillates (Stoddard Solvent)	Oil

NOTE * denotes that tests for this chemical are included in SAE J2031 standard tests.

11.4 Vibration test

All engine and skid mounted components shall be mounted on the vibration test machine and vibrated successively in each of three mutually perpendicular directions, respectively parallel to the edges of the component. The components shall be mounted on the vibration test machine in a configuration to accommodate testing in all three axis using any resilient mounts, carriers, or holding devices that are provided as a standard part of the component. The components shall be tested using a swept sine wave generator for a period of 8 hours in each of the three mutually perpendicular axes (vertical, horizontal, and longitudinal). Also, an investigation should be made for any resonant frequencies and, if necessary, a minimum dwell time of one hour should be added to test at these resonances. The accelerometer for the test should be located on the table adjacent to the device under test or as close as practical. The frequency range and vibration levels shall be per the Table 4 below. The rate of change of frequency shall not exceed 10 hertz per minute (Hz/minute).

Table 4
Vibration Test Requirements

Component	Frequency range (Hz)	Total Excursion (mm)	Acceleration (g)
All engine and skid mounted components	10 – 100	1.0	N/A
	100 – 1000	N/A	3
	1000 – 2000	N/A	2

At the conclusion of the test, the assembly shall have sustained no damage or loosening of parts. Continuity of connections shall have been maintained throughout the test.

11.5 Shielded secondary system tests

Shielded secondary lead assemblies shall comply with:

For Groups C or D, the applicable explosion testing and hydrostatic testing requirements of ANSI/UL 1203.

For Group IIA or IIB, the applicable reference pressure, overpressure, and flame transmission testing requirements of ANSI/ISA/UL 60079-1.

11.6 Spark plug pressure and temperature tests

Five spark plugs are to be installed per the manufacturer's specifications into a heated pressure chamber. The internal temperature of the chamber shall be elevated to 250°C (482°F) +/- 5.0 %. The chamber shall be pressurized to 6205 KPa (900 psig) +/- 5.0 % with nitrogen. The exterior surface of the spark plug shall be monitored for any leakage for a period no less than 24 hours. The upper portion of the spark plugs shall be enclosed in a liquid tight enclosure provided with viewing windows. The chamber shall be filled with 10 weight motor oil completely covering all five of the spark plugs. Leakage shall be determined by viewing the exterior of all spark plugs submerged in the motor oil. There shall be no visible leakage in the form of bubble (s) in the test liquid (10 weight motor oil) with any of the five spark plugs. An example of the apparatus for this test is illustrated in Figure 4.