SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

Submitted for recognition as an American National Standard

SAE J2031 | REV. MAY95

Issued 1990-01
Revised 1995-05

Superseding J2031 JAN90

(R) HIGH TENSION IGNITION CABLE

1. ***Scope***—The specifications contained in this SAE Standard pertain to high tension ignition cable used in road vehicle engine ignition systems.

2. ***References***

2.1 Applicable Document—The following publication forms a part of this specification to the extent specified herein.

2.1.1 UL PUBLICATION—Available from Underwriters Laboratories, 333 Pfingsten Road, Northbrook, FL 60062-2096.

UL 1581

2.2 Related Publications—The following publications are provided for information purposes only and are not required for this document.

2.2.1 ASTM PUBLICATION—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 471—Standard Test Method for Rubber Property—Effect of Liquids

2.2.2 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J2032—High Voltage Ignition Cable Assemblies

3. ***Cable Dimensions***—The average overall diameter of finished cable shall be 5 mm, 7 mm, or 8 mm. Other sizes are acceptable and testing will be as agreed on by manufacturer and customer. Allowable tolerance for either size shall be ±0.3 mm. The average overall diameter shall be determined by taking the average of five sets of measurements along a 1 m length of finished cable. Each set of measurements shall consist of the determination of the maximum and minimum diameter at the point of measurement.

4. ***Test Requirements***—When tested according to the methods outlined, the ignition cables covered by this document shall be capable of complying with the applicable requirements specified herein. Figure 1 defines the applicability of the test and provides specific performance criteria.

NOTE—Wherever the term "room temperature" is used, it shall be defined as 23 °C ± 5 °C.

Printed in U.S.A.

FIGURE 1—TEST APPLICABILITY AND PERFORMANCE CRITERIA

TEST	DESCRIPTION	CLASS TYPE	A		B		C		D		E		F	
			1 2	3 4	1 2	3 4	1 2	3 4	1 2	3 4	1 2	3 4	1 2	3 4
4.1	SPARK TEST		APPLY	DO NOT APPLY	APPLY	DO NOT APPLY	APPLY	DO NOT APPLY	APPLY	DO NOT APPLY	APPLY	DO NOT APPLY	APPLY	DO NOT APPLY
4.2	HIGH POTENTIAL TEST		TO BE APPLIED											
4.3	CAPACITANCE		CAPACITANCE SHALL BE AGREED ON BETWEEN CABLE MANUFACTURER AND USER											
4.4	CORONA RESISTANCE													
	5 mm CABLE		15 kV (RMS) 50 or 60 Hz											
	7 mm CABLE		15 kV (RMS) 50 or 60 Hz											
	7 mm H.E. CABLE		18 kV (RMS) 50 or 60 Hz											
	8 mm CABLE		18 kV (RMS) 50 or 60 Hz											
4.5	DEFORMATION TEST TEMPERATURE		70 °C ± 2 °C		105 °C ± 2 °C		120 °C ± 2 °C		NOT APPLICABLE		NOT APPLICABLE		NOT APPLICABLE	
4.6	THERMAL OVERLOAD TEST TEMPERATURE		105 °C ± 2 °C		120 °C ± 2 °C		155 °C ± 2 °C		180 °C ± 2 °C		220 °C ± 2 °C		250 °C ± 2 °C	
	MAX CHANGE IN RES.		+50%, −80%		+50%, −80%		+50%, −80%		+50%, −80%		+50%, −80%		+50%, −80%	
4.7	TEST FOR SHRINKAGE TEST TEMPERATURE		155 °C ± 2 °C		155 °C ± 2 °C		NOT APPLICABLE		NOT APPLICABLE		NOT APPLICABLE		NOT APPLICABLE	
	MAX. SHRINKAGE		2%		2%									
4.8	RES. TO FLAME PROPAGATION EXPOSURE TIME		30 s		30 s		30 s		15 s		15 s		15 s	
	EXTINCTION TIME		30 s		30 s		30 s		70 s		70 s		70 s	
4.9	LOW TEMPERATURE TEST TEMPERATURE		−20 °C ± 3 °C		−20 °C ± 3 °C		−30 °C ± 3 °C		−30 °C ± 3 °C		−40 °C ± 3 °C		−50 °C ± 3 °C	
4.10	MECHANICAL STRENGTH TEST													
4.10.1	RESISTIVE CABLE		N/A	30%	N/A	30%	N/A	30%	N/A	30%	N/A	30%	N/A	30%
4.10.2	REACTIVE CABLES		N/A	NO DISCON-TINUITY	N/A	NO DISCON-TINUITY	N/A	NO DISCON-TINUITY	N/A	NO DISCON-TINUITY	N/A	NO DISCON-TINUITY	N/A	NO DISCON-TINUITY
4.11	STRIPPING OF INSULATION		TO BE APPLIED											
4.12	RESISTANCE TO OIL		TO BE APPLIED											
4.13	RESISTANCE TO FLUIDS		TO BE APPLIED											
4.14	ACCELERATED LIFE TEST													
4.14.1	RES. TO SALT WATER		TO BE APPLIED											
4.14.2	RES. TO OIL		TO BE APPLIED											
4.14.3	RES. TO FUEL		TO BE APPLIED											
4.14.4	HIGH TEMPERATURE TEST TEMPERATURE		90 °C ± 2 °C		105 °C ± 2 °C		120 °C ± 2 °C		155 °C ± 2 °C		180 °C ± 2 °C		220 °C ± 2 °C	
4.14.5	LOW TEMPERATURE RES. TEST TEMPERATURE		−10 °C ± 3 °C		−15 °C ± 3 °C		−20 °C ± 3 °C		−20 °C ± 3 °C		−30 °C ± 3 °C		−40 °C ± 3 °C	

TYPE 1: CABLES WITH COPPER CONDUCTORS
TYPE 2: CABLES WITH STEEL CONDUCTORS
TYPE 3: CABLES WITH RESISTIVE CONDUCTORS
TYPE 4: CABLES WITH REACTIVE CONDUCTORS

NOTE—"H.E." = HIGH ENERGY

4.1 Spark Test—An AC spark test shall be performed on 100% of production of each ignition wire to which it is applicable (see Figure 1). Apparatus shall consist of a voltage source, electrode, voltmeter, fault-current device or system, and the necessary electrical connections. The recommended apparatus and test method shall be that described in UL 1581, Section 900. Test potential shall be 25 kV for 5 mm, 25 kV for 7 mm cable, and 30 kV for 7 mm High Energy or 8 mm cable.

NOTE—Alternate methods for this test may be considered provided that insulation faults are detected with the same degree of certainty.

4.2 High Potential Test—Refer to A.1 in Appendix A for test apparatus. Immerse an approximate 1200 mm specimen for 4 h in a salt solution (3% m/m of NaCL in water) at room temperature with the ends twisted together and emerging approximately 400 mm above the surface of the solution. Apply a test voltage of 20 kV (rms) for 30 min between the conductor and the solution.

NOTE—The applied potential is to be increased from near zero at an essentially uniform rate not to exceed 500 V/s.

The cable shall not break down. Then increase the voltage at a rate not exceeding 500 V/s to the following levels:

5 mm cable to 25 kV (rms)
7 mm cable to 30 kV (rms)
7 mm High Energy cable 35 kV (rms)
8 mm cable to 35 kV (rms)

Cable breakdown shall not occur below the voltage indicated.

4.3 Capacitance—Soak an approximate 1200 mm specimen in a salt solution (3% m/m NaCl in water) at 70 °C ± 2 °C for 24 h with each end of the cable emerging approximately 100 mm above the surface of the solution. Measure the capacitance between the conductor and the solution. Immerse the same specimen in tap water at 23 °C ± 2 °C for 1 h with each end of the cable emerging approximately 100 mm above the surface of the water. Again, measure the capacitance between the conductor and the water. The frequency applicable to both measurements shall be 1000 Hz. Measured capacitance values shall not exceed those agreed on between the cable manufacturer and the user.

4.4 Corona Resistance—Affix an approximate 1200 mm specimen to a mandrel as specified in A.2 in Appendix A. Apply the test potential specified in Figure 1 for a period of 8 h.

NOTE—The applied potential is to be increased from near zero at an essentially uniform rate not to exceed 500 V/s.

There shall be no breakdown of the cable, nor shall the surface of the specimen exhibit any cracks, fractures, or other defects.

4.5 Deformation Test—Determine the average thickness of the covering(s) over the conductor of an approximate 100 mm specimen of finished cable. Mount the specimen into the test apparatus shown in A.3 in Appendix A and load with the following mass:

5 mm cable to 312 g (include mass of test frame)
7 mm cable to 450 g (include mass of test frame)
7 mm High Energy cable to 450 g (include mass of test frame)
8 mm cable to 510 g (include mass of test frame)

Place the test unit into a full draft, circulating air oven maintained at the temperature specified in Figure 1 for a period of 4 h. Remove the test unit from the oven and cool within 10 s by immersing in cold water. Remove the specimen and measure the depth of the indentation in the area of the application of the load using an optical device. The value of this measurement shall not exceed 50% of the original average thickness of the covering(s).

4.6 Thermal Overload Test—Suspend an approximate 500 mm specimen vertically for 48 h in a full draft, circulating-air oven maintained at the temperature specified in Figure 1. Upon completion of the aging, remove the specimen from the oven and allow to cool to room temperature. Subject the specimen to winding test as defined in A.4, Appendix A. On completion of the windings, there shall be no evidence of cracks, fractures, or other defects. For resistive cables, measure the resistance of the cable at room temperature before and after the test. The allowable change in resistance shall not exceed the values specified in Figure 1.

4.7 Test for Shrinkage—This test shall apply where shrinkage of the conductor covering(s) is important with respect to the attachment of the connector. Measure the exact length (200 mm minimum) of a suitable specimen at room temperature. Place the specimen horizontally into a full draft, circulating-air oven maintained at the temperature specified in Figure 1 for a period of 15 min. Remove the specimen, cool to room temperature, and measure the length again. Maximum shrinkage shall not exceed the values shown in Figure 1. In addition, there shall be no evidence of cracks, fractures, or other defects in the surface of the specimen.

4.8 Resistance to Flame Propagation—For this test, a Bunsen or Tirrill gas burner having a barrel diameter of approximately 9.0 mm shall be employed. With the barrel vertical and the burner well away from the specimen, the height of the flame is to be adjusted to approximately 100 mm. The blue inner cone is to be approximately 50 mm high and the temperature at its tip is to be a minimum of 900 °C as measured using a chromel-alumel thermocouple. Suspend an approximate 500 mm specimen in a draft-free chamber and expose it to the tip of the inner cone of the flame, as shown in A.5 in Appendix A, for the period of time specified in Figure 1. Any combustion of the specimen must extinguish itself within the time specified in Figure 1 following the removal of the flame.

4.9 Low Temperature Test—Affix one end of an approximate 400 mm specimen to a 25 mm rotatable mandrel and attach a 4.5 kg mass to the free end. Subject the specimen, in a vertical position (i.e., with the mass freely hanging), to the temperature specified in Figure 1 for a period of 4 h. Without removing the sample from the freezing chamber, wind it a minimum of three turns onto the rotatable mandrel at a speed of one turn/second. There shall be no evidence of cracks, fractures, or other defects.

NOTE—If the test device is precooled, a freezing time of 2 h is sufficient.

4.10 Mechanical Strength Test—An approximate 1200 mm specimen shall be suspended as defined by A.6 in Appendix A and subjected to the following force for a period of 5 min:

5 mm cable—180 N
7 mm cable—250 N
7 mm High Energy cable—250 N
8 mm cable—250 N

4.10.1 RESISTIVE CABLE—For resistive cables, measure the resistance prior to the test on the full length of the specimen and again after the test on a 250 mm straight portion of the specimen that was under stress. The change in the resistance per unit length shall not exceed the value shown in Figure 1.

4.10.2 REACTIVE CABLE—For reactive cables, verify with approximately 12 V DC that there is no discontinuity in a 250 mm straight portion of the specimen that was under stress.

4.11 Stripping of Insulation—Where cables are required to be stripped, it shall be possible to remove at least 20 mm of insulation from the conductor cleanly and without difficulty. Specific stripping force values, when required, shall be agreed on between the manufacturer and the user.

4.12 Resistance to Oil—Measure the diameter of an approximate 400 mm specimen and then immerse for 48 h in ASTM No. 1 oil at a temperature of 90 °C ± 2 °C with the cable ends emerging approximately 50 mm 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 maximum change in diameter shall not exceed 15% nor decrease more than 5%. Subject the specimen to winding test as specified in A.4, Appendix A. On completion of the windings, there shall be no evidence of cracks, fractures, or other defects.

4.13 Resistance to Fuel—Measure the diameter of an approximate 400 mm specimen and then immerse in ASTM fuel C at room temperature for 30 min with cable ends emerging approximately 100 mm above the surface of the fuel. Remove the sample and allow to dry for approximately 30 min. The maximum change in diameter shall not exceed 15% nor decrease more than 5%. Subject the specimen to winding test as specified in A.4, Appendix A.

On completion of the windings, there shall be no evidence of cracks, fractures, or other defects.

4.14 Accelerated Life Test—Subject an approximate 1200 mm specimen to winding test as specified in A.4 in Appendix A, and then as specified in A.2. The specimen, while secured to the mandrel, shall then be subjected to each of the five tests outlined in the sequence listed. Test voltages shall be 15 kV (rms) for 5 mm and 7 mm cable and 20 kV (rms) for 7 mm High Energy and 8 mm cable. The test voltage shall be applied for 30 min while the mandrel is contained within a close-fitting, nonmagnetic metallic sleeve, which may have flared ends. Conditioning prior to the application of the test potential shall be conducted with the sleeve in position.

NOTE—The applied potential is to be increased from near zero at an essentially uniform rate not to exceed 500 V/s.

When immersed in liquids, the cable ends shall emerge approximately 100 mm above the surface of the liquid. There shall be no breakdown of the test specimen at any point in the sequential testing procedure.

4.14.1 RESISTANCE TO SALT WATER—Place the test specimen in a full draft, circulating-air oven maintained at 90 °C ± 2 °C for 4 h and then immediately immerse in a salt solution (3% m/m of NaCl in water) and maintain at 50 °C ± 2 °C for 16 h. Remove the specimen from the solution, drain for 30 min at room temperature, and then apply the specified voltage.

4.14.2 RESISTANCE TO OIL—Place the test specimen in a full draft, circulating-air oven maintained at 90 °C ± 2 °C for 4 h and then immediately immerse in ASTM No. 1 oil and maintain at 90 °C ± 2 °C for 16 h. Remove the specimen from the oil, drain for 30 min at room temperature, and then apply the specified voltage.

4.14.3 RESISTANCE TO FUEL—Immerse the test specimen in ASTM fuel C at room temperature for 30 min. Remove the specimen from the fuel, drain for 4 h with or without the sleeve, and then apply the specified voltage with the metallic sleeve in place.

4.14.4 HIGH TEMPERATURE RESISTANCE—Place the test specimen in a full draft, circulating-air oven maintained at the temperature shown in Figure 1 for a period of 48 h. Remove the specimen from the oven, cool to room temperature, and then apply the specified voltage.

4.14.5 LOW TEMPERATURE RESISTANCE—Remove the nonmagnetic metallic sleeve. Unwind the test specimen from the mandrel, leaving one end secured, and attach a 4.5 kg mass to the other end. With the mass fully supported by the test specimen, the entire arrangement shall be subjected to the temperature specified in Figure 1 for a period of 4 h. Without removing the specimen from the freezing chamber, wind it onto the mandrel for five complete turns at the rate of one turn in 5 s. Remove the sample from the freezing chamber, allow it to return to room temperature, remove weight and resecure free end, then replace the nonmagnetic metallic sleeve in place, and apply the specified voltage.

NOTE—If the test device is precooled, a freezing time of 2 h is sufficient.

5. Notes

5.1 Marginal Indicia—The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

PREPARED BY THE SAE HIGH VOLTAGE IGNITION CABLE TASK FORCE
AND APPROVED BY THE SAE IGNITION STANDARDS COMMITTEE

APPENDIX A

A.1 Test Apparatus for High Potential Test (see 4.2)

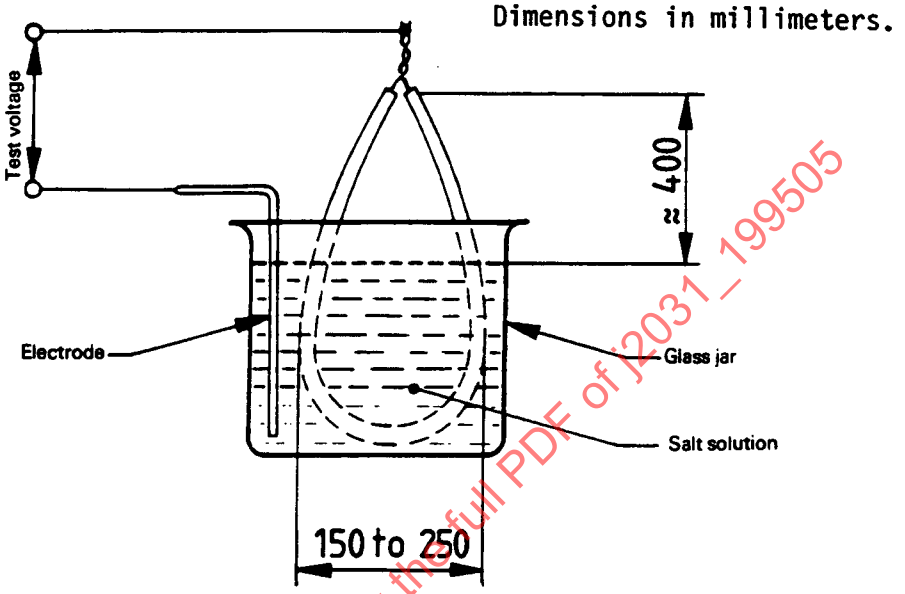

FIGURE A1—TEST APPARATUS FOR HIGH POTENTIAL TEST

A.2 Test Apparatus for Corona Resistance Test (see 4.4)—Winding of the cable: Attach to one end on the cable specimen a mass of 2.5 kg. Fix the free end of the specimen to a mandrel so that the mass can hang freely. Rotate the mandrel against the force exerted by the mass so that the cable specimen is wound up in five complete turns at a pitch of approximately 19 mm. During winding, the specimen shall not be forced against the natural torsion. Then fix the ends of the cable, remove the mass, and push a closely fitting sleeve over the specimen.

The sleeve and the mandrel shall be of nonmagnetic metal. The sleeve may have flared ends.

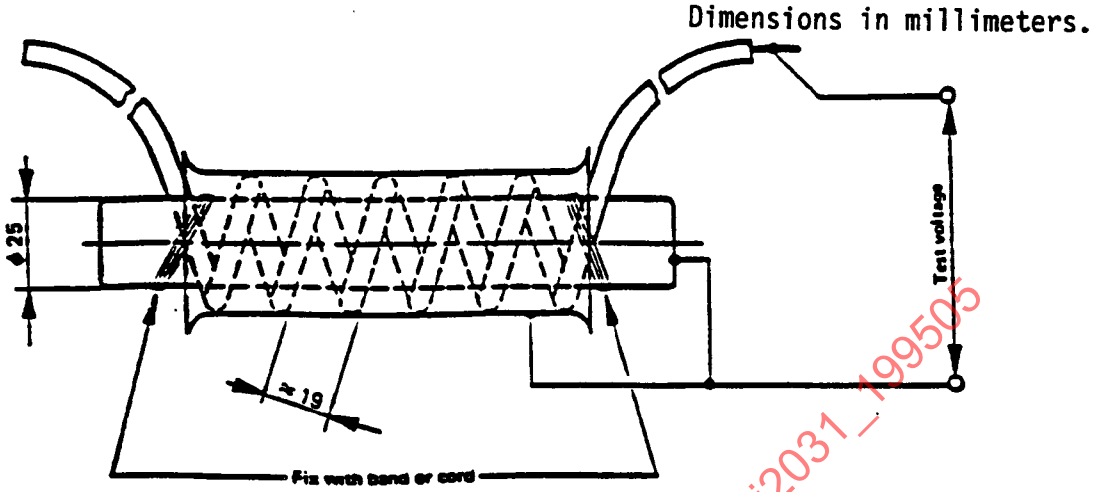

FIGURE A2—TEST APPARATUS FOR CORONA RESISTANCE TEST

A.3 Test Apparatus for Deformation Test (see 4.5)

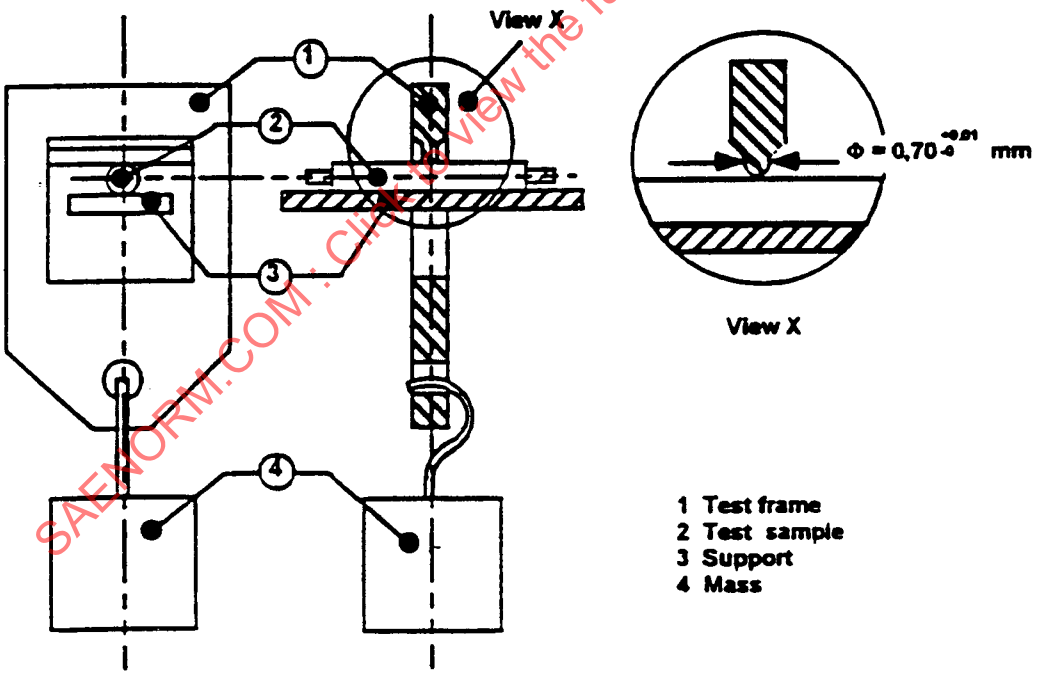

FIGURE A3—TEST APPARATUS FOR DEFORMATION TEST