

STANDARD INFORMATION

Standard Number: UL 60079-11

Standard Name: Explosive Atmospheres – Part 11: Equipment Protection by Intrinsic Safety “I”

Standard Edition and Issue Date: 6th Edition Dated February 15, 2013

Date of Revision: February 15, 2013

Date of Previous Revision of Standard: 5th Edition Revised May 5, 2011

EFFECTIVE DATE OF NEW/REVISED REQUIREMENTS

Effective Date: **December 31, 2019**

IMPACT, OVERVIEW, AND ACTION REQUIRED

Impact Statement: A review of all Listing Reports is necessary to determine which products comply with new/revised requirements and which products will require re-evaluation. **NOTE:** Effective immediately, this revised standard will be exclusively used for evaluation of new products unless the Applicant requests in writing that current requirements be used along with their understanding that their listings will be withdrawn on Effective Date noted above, unless the product is found to comply with new/revised requirements.

Overview of Changes:

- Addition of new test requirements for opto-isolators
- Introduction of Annex H about ignition testing of semiconductor limiting power supply circuits
- The merging of the requirements for combustible dust atmospheres
- The merging of the apparatus requirements

Specific details of new/revised requirements are found in table below.

If the applicable requirements noted in the table are not described in your report(s), these requirements will need to be confirmed as met and added to your report(s) such as markings, instructions, test results, etc. (as required).

Client Action Required:

Information – To assist our Engineer with review of your Listing Reports, please submit technical information in response to the new/revised paragraphs noted in the attached or explain why these new/revised requirements do not apply to your product (s).

Current Listings Not Active? – Please immediately identify any current Listing Reports or products that are no longer active and should be removed from our records. We will do this at no charge as long as Intertek is notified in writing prior to the review of your reports.



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CLAUSE	VERDICT	COMMENT
		<i>Additions to existing requirements are underlined and deletions are shown lined out below.</i>
		Grouping and classification of intrinsically safe apparatus and associated apparatus
4	Info	Intrinsically safe and associated apparatus which has a type of protection listed in IEC 60079-0 <u>for use in the appropriate explosive atmosphere, shall be grouped in accordance with equipment grouping requirements of IEC 60079-0 and shall have a maximum surface temperature or temperature class assigned in accordance with the temperature requirements of IEC 60079-0.</u>
		<u>Associated apparatus which has no such type of protection shall only be grouped in accordance with the equipment grouping requirements of IEC 60079-0.</u>
4DV.1	Info	DR Modification of Clause 4, second paragraph to replace with the following: <i>New clause added;</i>
4DV.1.1		Associated apparatus which has a type of protection listed in UL 60079-0 but not suitable to be located in the explosive atmosphere shall only be grouped in accordance with the equipment grouping requirements of UL 60079-0.
5	Info	Levels of protection and ignition compliance requirements of electrical apparatus
		General
		Intrinsically safe apparatus and intrinsically safe parts of associated apparatus shall be placed in Levels of Protection “ia”, “ib” or “ic”.
5.1		The requirements of this standard shall apply to all levels of protection unless otherwise stated. In the determination of level of protection “ia”, “ib” or “ic”, failure of components and connections shall be considered in accordance with 7.6. Failure of separations between conductive parts shall be considered in accordance with 6.3. <u>The determination shall include opening, shorting and earthing of the external intrinsically safe connection facilities in accordance with 6.2.</u>
		For circuits of associated apparatus which are connected to safety extra low-voltage circuits (SELV) or protective extra low-voltage circuits (PELV) circuits, Um shall only be applied as a ‘common mode’ voltage, with the nominal operating voltage applied for the differential mode signal between the circuit conductors. (Typical examples are RS-232, RS-485 or 4-20 mA circuits). The certificate number for associated apparatus relying on SELV or PELV circuits shall include the “X” suffix in accordance with the marking requirements of IEC 60079-0 and the specific conditions of use listed on the certificate shall detail the precautions necessary.



CLAUSE	VERDICT	COMMENT
5.1DV.1	Info	DR Modification of Clause 5.1, fourth paragraph to replace with the following: <i>New clause added;</i>
5.1DV.1.1		For circuits of associated apparatus which are connected to safety extra low-voltage circuits (SELV) or protective extra low-voltage circuits (PELV) circuits, U_m shall only be applied as a 'common mode' voltage, with the nominal operating voltage applied for the differential mode signal between the circuit conductors. (Typical examples are RS-232, RS-485 or 4-20 mA circuits). Associated apparatus relying on SELV or PELV circuits shall detail any special precautions necessary for installation.
5.5		Spark ignition compliance The circuit shall be assessed and/or tested for the successful limitation of the spark energy that may be capable of causing ignition of the explosive atmosphere, at each point where an interruption or interconnection may occur, in accordance with 10.1. <u>For Group III, the spark ignition tests to the requirements of Group IIB shall be applied to circuits exposed to dust.</u>
5.6	Info	Thermal ignition compliance
5.6.2		Temperature for small components for Group I and Group II <u>Requirements for temperatures of small components used in Group I or Group II equipment are provided in the small component temperature for Group I or Group II electrical equipment requirements of IEC 60079-0 and the test requirements are provided in the small component ignition test of IEC 60079-0.</u> <u>The 5 K and 10 K margin of safety required by the maximum surface temperature requirements of IEC 60079-0 does not apply to the maximum surface temperature values, 200 °C, 275 °C and 950 °C shown in the table for the assessment of temperature classification according to component size at 40 °C ambient temperature in IEC 60079-0.</u>
5.6.4		<u>In the absence of testing, where the maximum power does not exceed 1,3 W, the tracks are suitable for a temperature classification of T4 or Group I.</u> <u>In the absence of testing, where dust is excluded and the maximum power does not exceed 3,3 W, the tracks are suitable for Group I.</u> <u>Refer to the assessment of temperature classification for component surface areas > 20 mm² table in IEC 60079-0. Variation in maximum power dissipation with ambient temperature in IEC 60079-0 where a derating is required for ambient temperatures greater than 40 °C.</u>



CLAUSE	VERDICT	COMMENT
		<i>New clause added;</i>
		Intrinsically safe apparatus and component temperature for Group III
5.6.5		For determination of maximum surface temperature for intrinsically safe apparatus of Group III, refer to IEC 60079-0, temperature measurement. In particular the measurement shall be made using the specified values of U_i and I_i for the intrinsically safe apparatus without a 10 % safety factor. The temperature shall be that of the surface of the intrinsically safe apparatus that is in contact with the dust. For example, for intrinsically safe apparatus protected by enclosure of at least IP5X, the surface temperature of the enclosure shall be measured. Alternatively intrinsically safe apparatus shall be considered suitable for total immersion, or an uncontrolled dust layer thickness, if the matched power dissipation in any component is in accordance with Table 4, and the continuous short-circuit current is less than 250 mA. The intrinsically safe apparatus shall be marked T135 °C.
6	Info	Apparatus construction
6.1	Info	Enclosures
6.1.2	Info	Enclosures for Group I or Group II apparatus
		<i>New clause added;</i>
		General
6.1.2.1		Intrinsically safe and associated apparatus which rely on the spacings in Table 5 or Annex F shall be provided with an enclosure meeting the requirements of 6.1.2.2 or 6.1.2.3 as applicable.
		Apparatus complying with Table 5
6.1.2.2		Apparatus meeting the separation requirements of Table 5 shall be provided with an enclosure meeting the requirements of IP20 <u>in accordance with IEC 60529</u> or greater <u>according to the intended use and environmental conditions</u> . The enclosure does not need to be subjected to the tests for enclosures in IEC 60079-0; however for portable apparatus, the drop test of IEC 60079-0 still applies.
		Apparatus complying with Annex F
6.1.2.3		Apparatus meeting the separation requirements of Tables F.1 or F.2 shall be provided with protection to achieve pollution degree 2. This can be achieved by <u>one of the following</u> : a) an enclosure meeting the requirements of IP54 or greater according to the intended use and environmental conditions in accordance with IEC 60529. <u>For such enclosures the clauses of IEC 60079-0 identified in Table 1 additionally apply.</u>



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		<p>b) an enclosure meeting the requirements of IP20 or greater according to the intended use and environmental conditions in accordance with IEC 60529 provided that separations are obtained by using coating type 1 or type 2 or casting compound or through solid insulation. The enclosure does not need to be subjected to the tests for enclosures in IEC 60079-0; <u>however for portable apparatus, the drop test of IEC 60079-0 still applies.</u></p> <p><u>c) an enclosure meeting the requirements of IP20 and by restricted installation, provided that the restricted installation requirements shall be specified as Specific Conditions of Use and the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the installation requirements</u></p>
		<p><i>New clause added;</i></p>
6.1.2.3DV		<p>DR Modification of Clause 6.1.2.3, item c) to replace with the following:</p> <p>c) an enclosure meeting the requirements of IP20 and by restricted installation, provided that the restricted installation requirements shall be specified in the documentation.</p>
		<p><i>New clause added;</i></p>
		<p>Enclosures for Group III apparatus</p> <p>Where the intrinsic safety of intrinsically safe apparatus can be impaired by ingress of dust or by access to conducting parts, for example if the circuits contain infallible creepage distances, an enclosure is necessary by one of the following:</p>
6.1.3		<p>a) Where separation is accomplished by meeting the requirements for clearance or creepage distances of Table 5 or Annex F, the enclosure shall provide a degree of protection of at least IP5X, according to IEC 60529. For such enclosures the 6.1.2.3 a) shall additionally apply.</p> <p>b) Where separation is accomplished by meeting the requirements for distances under coating, casting compound or separation distances through solid insulation of Table 5 or Annex F, the enclosure shall provide a degree of protection of at least IP2X, according to IEC 60529. The enclosure does not need to be subjected to the tests for enclosures in IEC 60079-0; however for portable apparatus, the drop test of IEC 60079-0 still applies.</p>
		<p>Enclosures for Group III associated apparatus shall meet the requirements of 6.1.2.</p>
		<p><i>New clause added;</i></p>
		<p>Requirements for connections and accessories for IS apparatus when located in the non-hazardous area</p>
6.2.5		<p>Intrinsically safe apparatus may be provided with connection facilities that are restricted to use in a non-hazardous area e.g. data downloading and battery charging connections. Such facilities shall be provided with protection to ensure the ratings of the safety components within the intrinsically safe equipment comply</p>



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		<p>with 7.1. The use of a fuse protected shunt Zener assembly complying with 7.3 and 7.5.2 shall be considered sufficient protection for voltage limitation.</p> <p>Where these connections are provided for the connection of battery charger see also 7.4.9.</p> <p>Protection circuitry and components may reside either in the intrinsically safe apparatus or the non-hazardous area equipment. If any part of the protection circuit is located in the nonhazardous area accessory, it shall be assessed in accordance with this standard and the nonhazardous area accessory shall be stated in the documentation.</p> <p>The maximum voltage U_m that can be applied to these non-hazardous area connections shall be stated in the documentation, and marked on the intrinsically safe apparatus. The U_m at the connection facilities shall be assumed to be the normal mains supply voltage e.g. 250 V a.c. unless marked otherwise.</p> <p>Additionally, the circuit of the intrinsically safe apparatus shall be provided with means to prevent the delivery of ignition-capable energy to these safe area connections when in the hazardous area.</p>
6.3	Info	<p>Separation distances</p> <p>Separation distances that comply with the values in 6.1.1 of <u>Table 5 or Annex F under the conditions of 6.1.2.2, 6.1.2.3</u> or 6.1.3 shall not be subject to a fault.</p>
6.3.2		<p>Separation requirements shall not apply where earthed metal, for example tracks of a printed circuit board or a partition, separates an intrinsically safe circuit from other circuits, provided that breakdown to earth does not adversely affect the type of protection and that the earthed conductive part can carry the maximum current that would flow under fault conditions. <u>Creepage distance requirements shall not apply where earthed printed circuit board tracks separate conductive tracks requiring separation, but clearance requirements shall still be applied. Clearance requirements shall not apply where an earthed metallic partition of sufficient height does not allow a discharge between components requiring separation.</u></p>
		<p><i>New clause added;</i></p> <p>Distances according to Table 5</p>
6.3.2.1		<p>For Levels of Protection “ia” and “ib”, smaller separation distances, which are less than the values specified in Table 5 but greater than or equal to one-third of that value, shall be considered as subject to countable short-circuit faults if this impairs intrinsic safety.</p> <p>For Levels of Protection “ia” and “ib”, if separation distances are less than one-third of the values specified in Table 5, they shall be considered as subject to non-countable short-circuit faults if this impairs intrinsic safety.</p>



CLAUSE	VERDICT	COMMENT
		For Level of Protection “ic”, if separation distances are less than the values specified in Table 5, they shall be considered as short-circuits if this impairs intrinsic safety.
		New clause added;
		Distances according to Annex F
6.3.2.2		For Levels of Protection “ia” and “ib”, if separation distances are less than the values specified in Annex F, they shall be considered to fault as provided in F.3.1 if this impairs intrinsic safety.
		For Level of Protection “ic”, if separation distances are less than the values specified in Annex F, they shall be considered as short-circuits if this impairs intrinsic safety.
6.3.9		A solder mask alone is not considered as a conformal coating, but can be accepted as one of the two coats when an additional coat is applied, provided that no damage occurs during soldering. Other methods of application require only one coat, for example dip coating, brushing, or vacuum impregnating. A solder mask that meets the requirements of Annex A for a Type 1 <u>coating in accordance with IEC 60664-3</u> is considered as a conformal coating and an additional coating is not required. The manufacturer shall provide evidence of compliance with these requirements.
		The method used for coating the board shall be specified in the documentation according to the documentation requirements of IEC 60079-0. Where the coating is considered adequate to prevent conductive parts, for example soldered joints and component leads, from protruding through the coating, this shall be stated in the documentation and confirmed by examination. <u>The distances within the coating shall be in accordance with column 6 of Table 5.</u>
6.3.13	Info	Dielectric strength requirement
6.3.13DV.1	Info	DR Modification of Clause 6.3.13, first paragraph to replace with the following:
		New clause added;
6.3.13DV.1		The insulation between an intrinsically safe circuit and the frame of the electrical equipment or parts which may be earthed shall be capable of complying with the test described in 10.3 at an r.m.s. a.c. test voltage of twice the voltage of the intrinsically safe circuit or 500 V r.m.s., whichever is the greater. Where the circuit does not satisfy this requirement the documentation shall indicate the necessary information regarding the correct installation.
		Earth conductors, connections and terminals
6.5		<u>The following shall not be used:</u>



CLAUSE	VERDICT	COMMENT
		<p><u>a) terminals with sharp edges which could damage the conductors;</u> <u>b) terminals which may turn, be twisted or permanently deformed by normal tightening;</u> <u>c) insulating materials which transmit contact pressure in terminals.</u></p>
6.6	Info	Encapsulation General <u>Encapsulation may be applied by casting, moulding or pouring.</u> <u>Where encapsulation is used, it shall conform to the following and where appropriate it applies also to any potting box or parts of an enclosure used in the encapsulation process:</u> <u>a) have a temperature rating, specified by the manufacturer of the compound or apparatus, which is at least equal to the maximum temperature achieved by any component under encapsulated conditions;</u> <u>b) alternatively temperatures higher than the compound's rating shall be accepted provided that they do not cause damage to the compound. When the temperature of the compound exceeds its continuous operating temperature (COT), no visible damage of the compound that could impair the type of protection shall be evident, such as cracks in the compound, exposure of encapsulated parts, flaking, impermissible shrinkage, swelling, decomposition, or softening. In addition, the compound shall not show evidence of overheating that would adversely affect the protection;</u> <u>c) have at its free surface a CTI value of at least that specified in Table 5 or Annex F if any bare conductive parts protrude from the compound;</u> <u>d) only materials passing the test in 10.6.1 shall have its free surface exposed and unprotected, thus forming part of the enclosure;</u> <u>e) be adherent to all conductive parts, components and substrates except when they are totally enclosed by the compound;</u> <u>f) the compound shall be free of voids, except that encapsulation of components containing free space (transistors, relays, fuses etc) is allowed.</u> <u>g) be specified by its generic name and type designation given by the manufacturer of the compound.</u>
		Encapsulation used for the exclusion of explosive atmospheres <u>Where casting is used to exclude an explosive atmosphere from components and intrinsically safe circuits, it shall conform to 6.3.5.</u>
6.6.2		<u>Where moulding is used to exclude an explosive atmosphere from components and intrinsically safe circuits, the minimum thickness to the free surface shall comply with column 4 of Table 5, see Figures D.3a and D.3b.</u> In intrinsically safe apparatus where a compound is used to reduce the ignition capability of hot components, for example diodes and resistors, the volume and



CLAUSE	VERDICT	COMMENT
		thickness of the compound shall reduce the maximum surface temperature of the compound to the desired value.
7	Info	Components on which intrinsic safety depends
7.1	Info	Rating of components
7.1DV.1	Info	DR Modification of Clause 7.1, second paragraph to replace with the following and the addition of 7.1DV.1.2: <i>New clause added;</i>
7.1DV.1.1		Galvanically isolating components, such as transformers, relays, and opto-couplers that successfully withstand the appropriate tests in Clause 8 do not need to be rated for the fault voltage, current or power in the circuit, but instead shall be rated for at least the normal operating voltage current and power in the circuit. <i>New clause added;</i>
7.1DV.1.1		Thermal trips, fuses and switches shall be rated based on the normal operating voltage and current of the circuit.
7.3	Info	Fuses
7.3DV.1	Info	DR Modification of Clause 7.3, sixth paragraph and Note 1 to replace with the following: <i>New clause added;</i>
7.3DV.1.1		Fuses shall have a rated voltage of at least U_m (or U_i in intrinsically safe apparatus and circuits) and the external creepage distances and clearances shall conform to Table 5 or Annex F (but see 8.9). General industrial standards for the construction of fuses and fuseholders shall be applied and their method of mounting including the connecting wiring shall not reduce the clearances, creepage distances and separations afforded by the fuse and its holder. Where required for intrinsic safety, the distances to other parts of the circuit shall comply with 6.3.
7.3DV.2	Info	DR Modification of Clause 7.3, seventh paragraph to replace with the following: <i>New clause added;</i>
7.3DV.2.1		A fuse shall have a breaking capacity not less than the maximum prospective current of the circuit in which it is installed. For mains electricity supply systems not exceeding 250 V a.c., the prospective current shall normally be considered to be 1 500 A a.c. The breaking capacity of the fuse is determined according to IEC 60127 series or the ANSI/UL 248 series and shall be stated by the manufacturer of the fuses.
7.4	Info	Primary and secondary cells and batteries
		General
7.4.1	Info	If the cells or batteries have to be recharged in hazardous areas, the charging circuits shall be fully specified as part of the apparatus. The charging system shall be such that, even when faults in accordance with 5.2, 5.3 or 5.4 are applied to the



CLAUSE	VERDICT	COMMENT
		charging system, the charger voltage and current do not exceed the limits specified by the manufacturer.
7.4.1DV.1	Info	DR Modification of Clause 7.4.1, first paragraph to replace with the following and the deletion of NOTE 1: <i>New clause added;</i>
7.4.1DV.1.1		Contrary to the batteries requirements of UL 60079-0, cells and batteries are permitted to be connected in parallel in intrinsically safe apparatus and associated apparatus provided that intrinsic safety is not impaired. Cells and batteries in associated apparatus that are protected by one of the other types of protection listed in UL 60079-0 shall comply with the parallel battery prohibition of UL 60079-0. <i>New clause added;</i> Battery construction The spark ignition capability and surface temperature of cells and batteries used in intrinsically safe apparatus shall be tested or assessed in accordance with 10.5.3. The cell or battery construction shall be one of the following types: a) sealed (gas-tight) cells or batteries; b) sealed (valve-regulated) cells or batteries; c) cells or batteries which are intended to be sealed in a similar manner to items a) and b) apart from a pressure relief device. Such cells or batteries shall not require addition of electrolyte during their life and shall have a sealed metallic or plastic enclosure conforming to the following: 7.4.2 1) without seams or joints, for example solid-drawn, spun or moulded, joined by fusion, eutectic methods, welding or adhesives sealed with elastomeric or plastics sealing devices retained by the structure of the enclosure and held permanently in compression, for example washers and “o” rings; 2) swaged, crimped, shrunk on or folded construction of parts of the enclosure which do not conform with the above or parts using materials which are permeable to gas, for example paper based materials, shall not be considered to be sealed; 3) seals around terminals shall be either constructed as above or be poured seals of thermosetting or thermoplastic compound; d) cells or batteries encapsulated in a compound specified by the manufacturer of the compound as being suitable for use with the electrolyte concerned and conforming to 6.6. A declaration of conformance to a) or b) shall be obtained from the manufacturer of the cell or battery. Conformance to c) or d) shall be determined by physical examination of the cell or battery and where necessary its constructional drawings.



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7.4.4		For the purpose of evaluation and test, the cell voltage shall be that specified in Tables 6 and 7 <u>the primary cell table and secondary cells table</u> of IEC 60079-0. When a cell is not listed in these tables, it shall be tested in accordance with 10.4 to determine the maximum open circuit voltage, and the nominal voltage shall be that specified by the cell manufacturer.
7.4.8	Info	Batteries used but not replaced in explosive atmospheres
7.4.8DV		DR Modification of Clause 7.4.8, first paragraph to replace with the following: <u>If the cell or battery, requiring current-limiting devices to ensure the safety of the battery itself, is not intended to be replaced in the explosive atmosphere, it shall either be protected in accordance with 7.4.7 or alternatively it may be housed in a compartment capable of being opened or removed only with the aid of a tool. It shall also conform to the following:</u>
7.6		Failure of components, connections and separations For Levels of Protection “ia” and “ib”, where a component is rated in accordance with 7.1, its failure shall be a countable fault. For Level of Protection “ic”, where a component is rated in accordance with 7.1, it shall not be considered to fail. The application of 5.2 and 5.3 shall include the following: c) the failure of resistors to any value of resistance between open circuit and short circuit shall be taken into account (but see 8.5) <u>For thermal assessment, film or wirewound resistors operated up to 100 % of their rated power shall not be considered to fail;</u> <u>Where infallible separations are not encapsulated or covered by a coating in accordance with Clause 6.3 or are not protected by an enclosure with a rating of at least IP20 when exposing connection facilities, the spark test apparatus may be inserted across such separations.</u>
8	Info	Infallible components, infallible assemblies of components and infallible connections on which intrinsic safety depends
8.8		Wiring, printed circuit board tracks, and connections Wiring, printed circuit board tracks, including its connections which forms part of the apparatus, shall be considered as infallible against open circuit failure in the following cases: b) for printed circuit board tracks: 2) where a single track is at least 2 mm wide or has a width of 1 % of its length, whichever is greater. In both the above cases, the printed circuit board track shall comply with either of the following:



CLAUSE	VERDICT	COMMENT
		<p>– each track is formed from copper cladding having a nominal thickness of not less than 33 μm; or</p> <p>– the current carrying capacity of a single track or a combination of tracks is tested in accordance with 10.12;</p> <p>3) where tracks on different layers are connected by either a single via of at least 2 mm circumference or two parallel vias of at least 1 mm circumference, and these vias are joined to each other in accordance with 8.8b) 1) or 8.8b) 2).</p> <p>The vias shall comply with either of the following:</p> <p>– not less than 33 μm plating thickness; or</p> <p>– the current carrying capacity of a single via is tested in accordance with 10.12;</p>
		<p><i>New clause added;</i></p> <p>FISCO apparatus</p>
9.2		<p>Apparatus that has been constructed in accordance with Annex G and is intended to be used within a FISCO system, shall be additionally marked as ‘FISCO’ followed by an indication of its function, i.e. power supply, field device or terminator. (See Clause 12).</p>
		<p><i>New clause added;</i></p> <p>Handlights and caplights</p>
9.3		<p>Caplights for Group I shall comply with IEC 60079-35-1.</p> <p>Handlights and caplights for Groups II and III shall comply with the requirements of this standard.</p>
10	Info	Type verifications and type tests
10.1	Info	Spark ignition test
10.1.5	Info	Testing considerations
		<p>Circuits with both inductance and capacitance</p> <p>The circuit shall be assessed for compliance with either of the following methods:</p> <p>a) tested with the combination of capacitance and inductance, or</p> <p>b) where linear (resistive current limiting) circuits are being considered</p> <p>1) the values of L_o and C_o determined by the ignition curves and table given in Annex A are allowed for;</p> <p>– <u>distributed inductance and capacitance e.g. as in a cable or,</u></p> <p>– <u>if the total L_i of the external circuit (excluding the cable) is < 1 % of the L_o value or,</u></p> <p>– <u>if the total C_i of the external circuit (excluding the cable) is < 1 % of the C_o value.</u></p> <p>2) the values of L_o and C_o determined by the ignition curves and table given in</p>
10.5.1.2		



CLAUSE	VERDICT	COMMENT
		<p>Annex A shall be reduced to 50 % if both of the following conditions are met;</p> <ul style="list-style-type: none">– <u>the total L_i of the external circuit (excluding the cable) ≤ 1 % of the L_o value</u>and– <u>the total C_i of the external circuit (excluding the cable) ≤ 1 % of the C_o value.</u> <p><u>The reduced capacitance of the external circuit (including cable) shall not be greater than 1 μF for Groups I, IIA, and IIB and 600 nF for Group IIC.</u></p> <p><u>The values of L_o and C_o determined by this method shall not be exceeded by the sum of all of the L_i plus cable inductances in the circuit and the sum of all of C_i plus cable capacitances respectively.</u></p>
		<p>Circuits using shunt short-circuit (crowbar) protection</p>
10.1.5.3		<p>After the output voltage has stabilized, the circuit shall be incapable of causing ignition for the appropriate level of protection of apparatus in the conditions of Clause 5. Additionally, where the type of protection relies on operation of the crowbar caused by other circuit faults, the let-through energy of the crowbar during operation shall not exceed the following value for the appropriate group:</p> <ul style="list-style-type: none">– Group IIB and Group III apparatus 80 μJ
10.5	Info	<p>Tests for cells and batteries</p>
		<p>Spark ignition and surface temperature of cells and batteries</p>
		<p>Cells and batteries shall be tested or assessed as follows.</p>
10.5.3		<p>b) <u>Cells shall be tested at any temperature between laboratory ambient and the specified maximum ambient that gives the most onerous conditions and the values obtained shall be used directly in the temperature class assessment. The cells shall be arranged in a way as to simulate the thermal effects of their intended position in the complete apparatus. The temperature shall be determined on the hottest surface of the cell that may be exposed to the explosive atmosphere and the maximum figure taken. If an external sheath is fitted then the temperature shall be measured at the interface of the sheath and the metal surface of the cell or battery.</u></p> <p><u>The maximum surface temperature shall be determined as follows:</u></p> <p><u>For ‘ia’ and ‘ib’ all current-limiting devices external to the cell or battery shall be short-circuited for the test. The test shall be carried out both with internal current-limiting devices in circuit and with the devices short-circuited using 10 cells in each case. The 10 samples having the internal current-limiting devices short-circuited shall be obtained from the cell/battery manufacturer together with any special instructions or precautions necessary for safe use and testing of the samples. If the internal current limiting devices protect against internal shorts then these devices need not be removed. However, such devices shall only be considered for Level of</u></p>



CLAUSE	VERDICT	COMMENT
		<p><u>Protection 'ib'.</u></p> <p><u>c) For 'ic' the maximum surface temperature shall be determined by testing in normal operating conditions with all protection devices in place.</u></p>
10.6	Info	<p>Mechanical tests</p> <p>Casting compound</p> <p>A force of 30 N shall be applied perpendicular to the exposed surface of casting compound with a 6 mm diameter flat ended metal rod for 10 s. No damage to or permanent deformation of the encapsulation or movement greater than 1 mm shall occur.</p> <p>10.6.1</p> <p>Where a free surface of casting compound occurs and forms part of the enclosure, in order to ensure that the compound is rigid but not brittle, the impact tests shall be carried out on the surface of the <u>casting compound in accordance with IEC 60079-0 using the drop height h in row a) of the tests for resistance to impact table of IEC 60079-0.</u></p>
10.7	Info	<p>Tests for intrinsically safe apparatus containing piezoelectric devices</p>
10.7DV.1	Info	<p>DR Modification of Clause 10.7, fifth paragraph to replace with the following:</p>
10.7.DV.1.1		<p>Where it is necessary to protect the intrinsically safe apparatus from external physical impact in order to prevent the impact energy exceeding the specified values, details of the requirements shall be specified in the documentation and the documentation shall detail the requirements.</p>
10.11		<p><i>New section added;</i></p> <p>Optical isolators tests</p> <p>General</p> <p>The following tests shall be performed if optical isolators are used to provide isolation between intrinsically safe circuits and non-intrinsically safe circuits and are not adequately protected against overload by external protection components (see 8.9.2).</p> <p>The samples shall successfully comply with both the tests specified in 10.11.2 and 10.11.3.</p>
10.11.2		<p>Thermal conditioning, dielectric and carbonisation test</p> <p>The maximum temperature measured at the receiver side and at the transmitter side shall be determined by overloading the devices. These shall then be subjected to thermal conditioning and dielectric strength tests. A carbonisation test shall then be conducted to check for formation of internal creepage paths.</p>



CLAUSE	VERDICT	COMMENT
10.11.2.1		<p>Overload test at the receiver side</p> <p>This test shall be conducted on five samples. The transmitter side of the optical isolator shall be operated with the rated load values (e.g. $I_f = I_N$).</p> <p>The receiver side shall be operated with a specific power (e.g. between collector and emitter), which shall not damage the components. This value shall be determined either by preliminary tests or taken from the data sheet.</p> <p>After thermal equilibrium has been reached, the power shall be increased. After thermal equilibrium has been reached again, the power shall be increased further in steps, until thermal equilibrium, and so on, until the receiver semiconductor is damaged. This will terminate or drastically reduce the power dissipation.</p> <p>The maximum surface temperature of the receiver side just before the damage of the receiver shall be recorded for each sample together with the ambient temperature.</p>
10.11.2.2		<p>Overload test at the transmitter side</p> <p>This test shall be conducted on five samples.</p> <p>The receiver side of the optical isolator is operated at the rated values of voltage and current (e.g. VC-E, IC).</p> <p>The transmitter side shall be operated with a specific power, which shall not damage the components. This value shall either be determined by preliminary tests or taken from the data sheet.</p> <p>After thermal equilibrium has been reached, the power shall be increased. After thermal equilibrium has been reached again, the power shall be increased further in steps, until thermal equilibrium, and so on, until the transmitter semiconductor is damaged. This will terminate or drastically reduce the power dissipation.</p> <p>The maximum surface temperature of the transmitter side just before the damage of the transmitter shall be recorded for each sample together with the ambient temperature.</p>
10.11.2.3		<p>Thermal conditioning and dielectric strength test</p> <p>All 10 samples used in 10.11.2.1 and 10.11.2.2 shall be placed in an oven for 6 0 +0.2 h at the maximum surface temperature recorded from 10.11.2.1 or 10.11.2.2 increased by at least 10 K but at most 15 K.</p> <p>After the optical isolators have cooled down to $(25 \pm 2) ^\circ\text{C}$ they shall be subjected to dielectric strength test with a voltage of 1,5 kV (a.c. 48 Hz to 62 Hz) applied</p>



CLAUSE	VERDICT	COMMENT
		<p>between intrinsically safe and non-intrinsically safe terminals and within 10 s increased to 3 0 +5% kV. This voltage shall be applied for (65 ± 5) s.</p> <p>During this test, there shall be no breakdown of the insulation between the receiver and the transmitter and the leakage current shall not exceed 5 mA.</p>
10.11.2.4		<p>Carbonisation test</p> <p>Receiver side</p> <p>Using the five samples of 10.11.2.1, a d.c. voltage of 375 +10% V shall be applied for 30 +1 min across the terminals (e.g. collector and emitter) of the failed receiver semiconductor, to test the formation of an internal creepage path caused by the heated plastic material (carbonisation).</p> <p>During the last 5 min of this test, the current shall not exceed 5 mA.</p>
10.11.2.4.1		
		<p>Transmitter side</p> <p>Using the five samples of 10.11.2.2, a d.c. voltage of 375 +10% V shall be applied for 30 +1 min across the terminals of the failed transmitter (e.g. diode), to test the formation of an internal creepage path caused by the heated plastic material (carbonisation).</p> <p>During the last 5 min of this test the current shall not exceed 5 mA.</p>
10.11.2.4.2		
10.11.3		<p>Dielectric and short-circuit test</p> <p>General</p>
10.11.3.1		<p>Optical isolators shall be subjected to a dielectric strength test, followed by a short-circuit current test and if applicable to the current limited short-circuit current test described below, followed by a dielectric strength test.</p>
		<p>Pre-test dielectric</p> <p>Three new samples shall be used for this test, with an additional three samples if 10.11.3.4 applies.</p> <p>Prior to the short-circuit current tests, the samples of the optical isolator shall be capable of withstanding without breakdown a dielectric strength test of 4 +5% kV rms applied between the intrinsically safe side and the non-intrinsically safe side of the optical isolator.</p>
10.11.3.2		



CLAUSE	VERDICT	COMMENT
		Short-circuit current test
10.11.3.3		Three samples of the optical isolator shall be subjected to a short-circuit current test. The open circuit voltage of the test circuit shall be U_m . The available instantaneous short-circuit current capacity of the test circuit shall be at least 200 A. The test circuit shall be connected to the optical isolator so that the test current flows through the non-intrinsically safe side of the optical isolator. Protective components or assemblies that form part of the circuit are permitted to remain connected for the test.
		Current limited short-circuit current test
10.11.3.4		Where optical isolators have protective series fuses or current-limiting resistors, three additional samples of the optical isolator shall be subjected to 1,7 times the nominal current rating of the fuse or 1,5 times the calculated short-circuit current through the resistor under fault conditions, until temperatures reach equilibrium.
		Dielectric strength test
10.11.3.5		Each sample shall withstand without breakdown a dielectric strength test of $2 U + 1\,000\text{ V}$ or $1\,500\text{ V rms}$, whichever is greater, applied between the intrinsically safe side and the non-intrinsically safe side of the optical isolator for $(65 \pm 5)\text{ s}$. During these tests the optical isolators shall not explode or catch fire throughout the short-circuit current tests, and the current shall not exceed 1 mA during the dielectric strength tests.
		<i>New clause added;</i>
		Current carrying capacity of infallible printed circuit board connections
10.12		The current carrying capacity of the connection shall be tested for at least 1 h with a current of 1,5 times the maximum continuous current which can flow in the connection under normal and fault condition. The application of this test current should not cause the connection to fail to open-circuit or to be separated from its substrate at any point.
		CUSTOMERS PLEASE NOTE: This Table and column “Verdict” can be used in determining how your current or future production is or will be in compliance with new/revised requirements.