Where it is necessary to protect the apparatus from external physical impact in order to prevent the impact energy of 10.7 exceeding the specified values, details of the requirements shall be specified and the documentation ~~as special conditions for safe 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 requirements

For apparatus complying with the requirements of Annex G, each piece of apparatus shall additionally be marked with the word "FISCO" followed by an indication of its function, i.e. power supply, field device or terminator.

Where apparatus is dual marked so that it can be used in both a FISCO system and a conventional intrinsically safe system, care shall be taken to differentiate between the FISCO marking and the marking for the conventional intrinsically safe system.

In the case of FISCO power supplies, output parameters U_o, I_o, C_o, L_o, P_o and L_o/R_o and FISCO field devices or terminators, input and internal parameters U_i, I_i, C_i, L_i, P_i and L_i/R_i need not be marked.

12.2 Marking of connection facilities

Connection facilities, terminal boxes, plugs and sockets of intrinsically safe apparatus and associated apparatus shall be clearly marked and shall be clearly identifiable. Where a colour is used for this purpose, it shall be light blue for the intrinsically safe connections.

Where parts of an apparatus or different pieces of apparatus are interconnected using plugs and sockets, these plugs and sockets shall be identified as containing only intrinsically safe circuits. Where a colour is used for this purpose, it shall be light blue.

In addition, sufficient and adequate marking shall be provided to ensure correct connection for the continued intrinsic safety of the whole.

NOTE It may be necessary to include additional labels, for example on or adjacent to plugs and sockets, to achieve this. If clarity of intention is maintained, the apparatus label may suffice.

12.3 Warning markings

Where any of the following warning markings are required on the apparatus, the text as described in Table 11, following the word "WARNING," may be replaced by technically equivalent text. Multiple warnings may be combined into one equivalent warning.

Table 11 – Text of warning markings

Item	Reference	WARNING Marking
a)	7.4.1	WARNING – USE ONLY *YYYYY* BATTERIES (where Y is the cell manufacturers name and the type number of the cell or battery).
b)	7.4.8	WARNING – DO NOT REPLACE BATTERY WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT
c)	7.4.9	WARNING – DO NOT CHARGE THE BATTERY IN HAZARDOUS LOCATION
d)	7.4.8	WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT

12.4 Examples of marking

The following are examples of marking.

a) Self-contained intrinsically safe apparatus

C TOME LTD
PAGING RECEIVER TYPE 3
Ex ia IIC T4
–25 °C ≤ Ta ≤ +50 °C
IECEx ExCB 04.****
Serial No. XXXX

b) Intrinsically safe apparatus designed to be connected to other apparatus

M HULOT	
TRANSDUCTEUR TYPE 12	
Ex ib IIB T4	
ACB No: Ex05****	
L_i: 10 µH	C_i: 1 200 pF
U_i: 28 V	I_i: 250 mA
P_i: 1,3 W	

c) Associated apparatus

J SCHMIDT A.G.	
STROMVERSORGUNG TYP 4	
[Ex ib] I	
ACB No: Ex05****	
U_m: 250 V	P_o: 0,9 W
I_o: 150 mA	U_o: 24 V
L_o: 20 mH	C_o: 4,6 µF

d) Associated apparatus protected by a flameproof enclosure

PIZZA ELECT. SpA	
Ex d [ia] IIB T6	
ACB No: Ex05****	
U_m: 250 V	P_o: 0,9 W
U_o: 36 V	I_o: 100 mA
C_o: 0,31 µF	L_o: 15 mH
Serial No. XXXX	

e) Intrinsically safe apparatus Level of Protection “ic”

M HULOT	
TRANSDUCTEUR TYPE 12A	
Ex ic IIB T4	
ACB No: Ex05****	
U_i: 28 V	C_i = 0

f) Intrinsically safe apparatus Level of Protection ‘ib’ with ‘ia’ outputs

PRAHA ELECT	
Ex ib [ia IIC] IIB T6	
ACB No: Ex09****	
U_i: 30 V	Uo: 5.6V
I_i: 93 mA	P_o: 0.014 W
Li: 0.01 mH	I_o: 10 mA
C_i: 0.031 µF	L_o: 0.15 mH
Serial No. XXXX	C_o: 35 uF

where ACB represents the initials of the certifying body, as applicable.

13 Documentation

The documentation shall include the instructions required by the instructions requirements of ISA-60079-0 ~~IEC 60079-0~~, and shall include the following information as applicable:

a) electrical parameters for the entity concept:
   1) power sources: output data such as U_o, I_o, P_o and, if applicable, C_o, L_o and/or the permissible L_o/R_o ratio;
   2) power receivers: input data such as U_i, I_i, P_i, C_i, L_i and the L_i/R_i ratio;

b) any special requirements for installation, live maintenance and use;

NOTE A control drawing is a recommended form of consolidating connection information and special requirements for installation and use.

c) the maximum value of U_m which may be applied to terminals of non-intrinsically safe circuits or associated apparatus;

d) any special conditions which are assumed in determining the type of protection, for example that the voltage is to be supplied from a protective transformer or through a diode safety barrier;

e) conformance or non-conformance with 6.3.13;

f) the designation of the surfaces of any enclosure only in circumstances where this is relevant to intrinsic safety;

g) the environmental conditions for which the apparatus is suitable;

h) If Annex F has been applied, the documentation shall state the ambient pollution degree and overvoltage category.

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Annex A
(normative)

Assessment of intrinsically safe circuits

A.1 Basic criteria

An intrinsically safe circuit shall satisfy three basic criteria:

a) no spark ignition shall result when the circuit is tested, or assessed as required by Clause 10 for the specified level of protection (see Clause 5) and grouping (see Clause 4) of electrical apparatus;

b) the temperature classification of intrinsically safe apparatus shall be carried out in accordance with 5.6 and the temperatures requirements of ANSI/ISA-60079-0~~IEC 60079-0~~ so as to ensure that ignition is not caused by hot surfaces. Temperature classification shall not apply to associated apparatus;

c) the circuit shall be adequately separated from other circuits.

NOTE 1 Criterion a) may be satisfied by assessment. Information relating to voltage, current and circuit parameters such as capacitance and inductance at the boundary for ignition is necessary. The circuit can then be assessed as intrinsically safe in regard to spark ignition.

NOTE 2 Criterion b) may be satisfied by estimating the maximum surface temperatures of components from knowledge of their thermal behaviour and the maximum power to which they may be subjected under the appropriate fault conditions.

NOTE 3 Criterion c) may be satisfied by the provision of adequate creepage distances and clearances, and by the use of components conforming to Clause 8, for example transformers and current-limiting resistors.

A.2 Assessment using reference curves and tables

Where the circuit to be assessed for ignition capability approximates to the simple circuit from which the curve is derived, Figures A.1 to A.6 or Tables A.1 and A.2 shall be used in the assessment. The fault conditions in accordance with Clause 5 and the safety factors in accordance with 10.1.4.2 shall also be taken into account.

Generally, the following procedure shall be applied:

– determine the worst practical situation taking account of component tolerances, supply voltage variations, insulation faults and component faults;

– then apply the appropriate safety factors, which depend on the type of circuit (see 10.1.4.2) as well as on the level of protection of the electrical apparatus (see Clause 5), in order to derive a circuit to be subjected to assessment;

– then check that the parameters of the resultant circuit are acceptable according to the reference curves in Figures A.1 to A.6 or according to Tables A.1 and A.2.

The circuit derived for assessment purposes may be tested using the spark-test apparatus if testing is preferred to assessment.

NOTE The information provided in Figures A.1 to A.6 and Tables A.1 and A.2 relates only to simple circuits and it may be difficult in some cases to apply the information to the design of practical circuits. For example, many power supplies have non-linear output characteristics and are not assessable from the reference curves because Figure A.1 can only be used when the circuit can be represented by a cell or battery and a series current-limiting resistor. Because of this, non-linear circuits, for example constant current circuits, will give ignition at lower values of current than would be predicted from Figure A.1 on the basis of open-circuit voltage and short-circuit current. In some types of non-linear circuit, the maximum permitted current may be only one-fifth of that predicted from reference curves. Great care is therefore needed to ensure that assessments are made only when the circuit under consideration can, for practical purposes, be represented by one of the simple circuits for which information is provided. The information available is limited and cannot cover all the detailed problems that arise in the design of intrinsically safe circuits.

A.3 Examples of simple circuits

a) Simple inductive circuit

To illustrate the procedure in more detail, consider a circuit for Group IIC consisting of a power supply comprising a 20 V battery with a suitably mounted infallible 300 Ω current-limiting resistor feeding into a 1 100 Ω, 100 mH inductor as shown in Figure A.7.

The 300 Ω and 1 100 Ω values are minimum values and 100 mH is a maximum value. Two separate assessments are made: one to ensure that the power supply itself is intrinsically safe and the other to take account of the effect of the connected load as follows.

1) Power supply

The steps in the assessment are the following.

i) The value of the current-limiting resistor is quoted as 300 Ω minimum and this represents the worst situation as far as the resistor is concerned. If this resistor does not conform to the requirements for infallibility (see 8.5), application of a single fault (see Clause 5) would produce a modified circuit in which the resistor would be assumed to be short-circuited. With such a fault, the power supply would not be intrinsically safe.

It is also necessary to determine a maximum value for the battery voltage in accordance with 7.4.4. Assume the maximum battery voltage derived is 22 V.

ii) The maximum short-circuit current is 22/300 = 73,3 mA.

Since the circuit is resistive, application of the requirements of Clause 5 and 10.1.4.2 give rise to a modified circuit in which the short-circuit current is increased to 1,5 × 73,3 = 110 mA.

iii) From Table A.1, it can be seen that, for Group IIC, the minimum igniting current for a resistive circuit at 22 V is 337 mA. The power supply can therefore be assessed as intrinsically safe in regard to spark ignition.

2) Connection of load

The steps in the assessment are as follows.

i) The maximum battery voltage is 22 V. Since 300 Ω and 1 100 Ω are minimum values, the maximum possible current in the load is 22/(300 + 1 100) = 15,7 mA. No faults need to be applied since the 300 Ω resistor is infallible and short-circuit failure of the inductor leads to the circuit considered above.

ii) Application of the requirements of Clause 5 and 10.1.4.2 requires that, for a safety factor of 1,5, the current in the circuit be increased to 1,5 × 15,7 = 23,6 mA.

iii) Reference to Figure A.4 for Group IIC shows that, for a 100 mH inductor, the minimum igniting current for a source of 24 V is 28 mA. The circuit can therefore be assessed as intrinsically safe in regard to spark ignition for Group IIC applications.

NOTE 1 For open-circuit voltages significantly below 24 V, Figure A.6 should be used.

NOTE 2 The above assessment assumes that the inductor is air-cored. If the inductor is not air-cored, such assessments can be regarded as only approximate and it is necessary to test the circuit with the spark-test apparatus (Annex B) in order to establish whether or not it is intrinsically safe. In practice, if the assessment is based on a measured inductance value, the actual minimum igniting current is usually, although not always, greater than the assessed value.

b) Simple capacitive circuit

Consider now the circuit of Figure A.8 which is intended for Group I application. It consists of a 30 V battery connected to a 10 μF capacitor through a suitably mounted infallible 10 kΩ resistor. For the purpose of this example, the values of 30 V and 10 μF are taken as maximum values, and 10 kΩ as a minimum value.

Two separate assessments are made: one to ensure that the power supply itself is intrinsically safe and the other to take account of the presence of the capacitor.

1) Power supply

   Since the procedure is almost exactly that described in a) 1), no detail need be given. The power supply circuit alone can be readily assessed as being intrinsically safe in regard to spark ignition with a safety factor exceeding 100.

2) Capacitor

   The steps in the assessment are as follows.

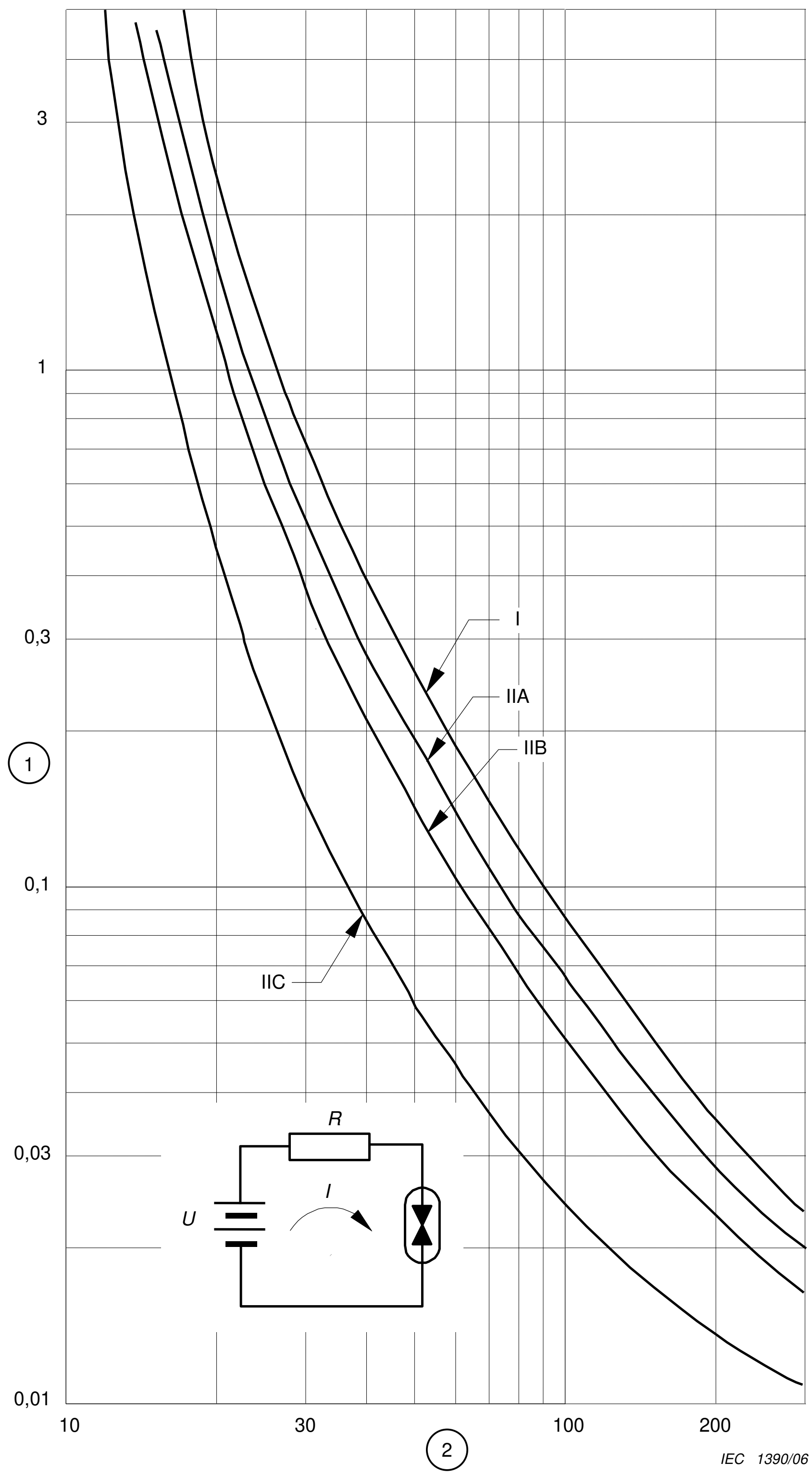
   i) The maximum battery voltage is 30 V, and 10 μF is the maximum capacitance value. No faults are applied since the 10 kΩ resistor is infallible and either short-circuit or open-circuit failure of the capacitor gives rise to the circuit considered in b) 1).

   ii) Application of the requirements of Clause 5 and 10.1.4.2 requires that, for a safety factor of 1,5, the voltage be increased to 1,5 × 30 V = 45 V.

   iii) Reference to Figure A.2 for Group I shows that at 45 V the minimum value of capacitance to give ignition is only 3 μF and at 30 V only 7,2 μF, so that the circuit cannot be assessed as intrinsically safe.

NOTE 3 To modify the circuit so that it may be assessed as being intrinsically safe, there are several possibilities. The circuit voltage or capacitance values could be reduced, or an infallible resistor could be inserted in series with the 10 μF capacitor. Reference to Figure A.2 shows that the minimum igniting voltage for 10 μF is 26 V, so that the battery voltage would have to be reduced to 26/1,5 = 17,3 V if the value of 10 μF were to be maintained. Alternatively, the capacitance value could be reduced to 3 μF, or, since 10 μF + 5,6 Ω gives a minimum igniting voltage of 48 V, insertion of an infallible resistor having a minimum value of 5,6 Ω in series with the capacitor would also produce a circuit which could be assessed as intrinsically safe as regards spark ignition for Group I.

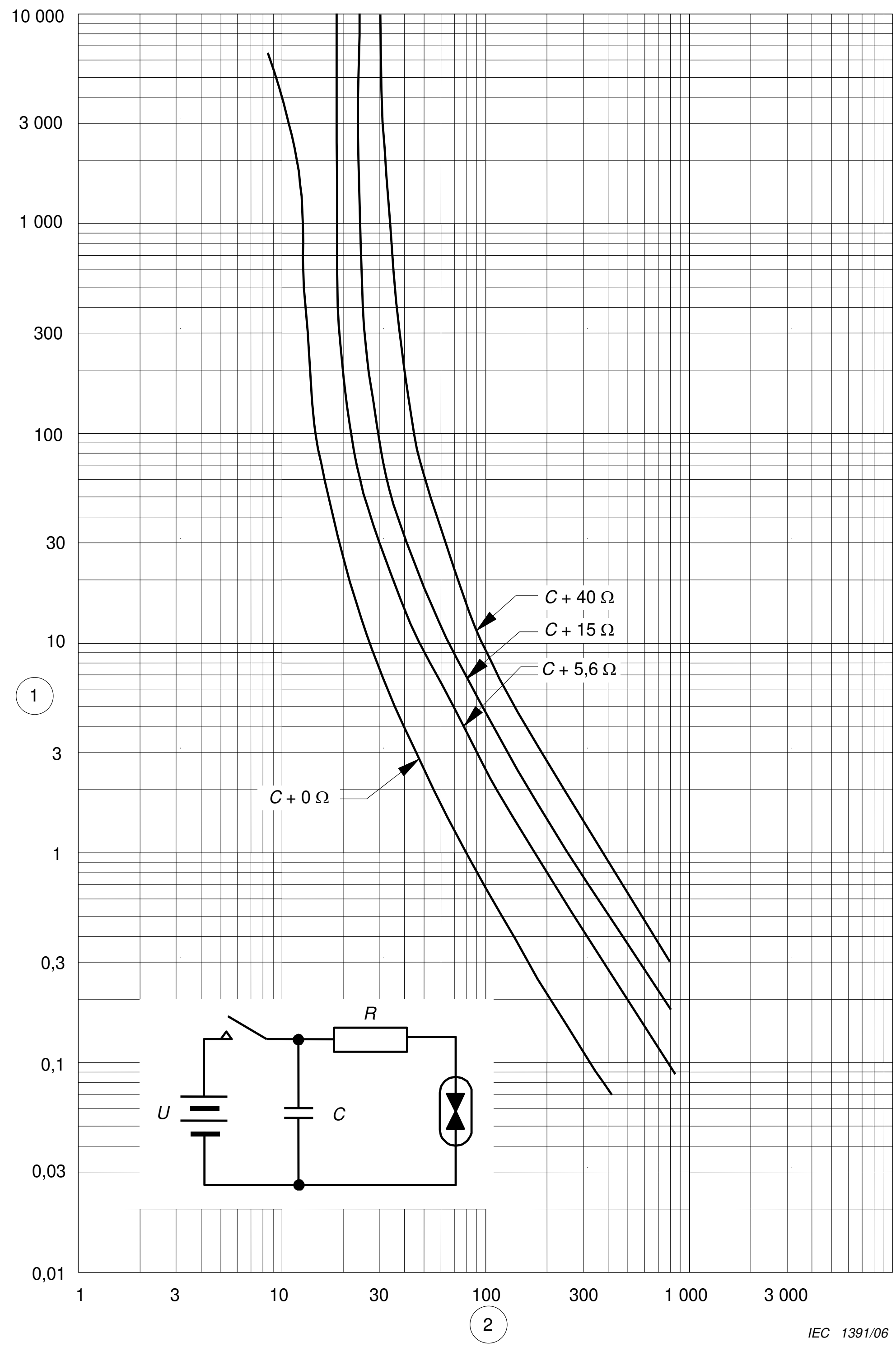
NOTE 4 One problem ignored in the above discussion is that, strictly speaking, the minimum igniting voltage curves for capacitive circuits in Figures A.2 and A.3 relate to a charged capacitor not directly connected to a power supply. In practice, provided the power supply considered by itself has a large safety factor, as in the above example, the reference curves can be applied. If, however, the power supply alone has only a minimum safety factor, interconnecting it with a capacitor can lead to a situation where the circuit is not intrinsically safe even though intrinsic safety may be inferred from Figures A.2 and A.3. In general, such circuits cannot be reliably assessed in the manner described above and should be tested with the spark test apparatus (see Annex B).



Key

1 Minimum ignition current *I* (A) 2 Source voltage *U* (V)

Figure A.1 – Resistive circuits



Key

1 Capacitance *C* (μF)

2 Minimum igniting voltage *U* (V)

NOTE The curves correspond to values of current-limiting resistance as indicated.

Figure A.2 – Group I capacitive circuits