Alteration of the internal components of the equipment is not permitted without re-evaluation of the equipment because conditions may be created inadvertently which lead to pressure-piling, change in temperature class, or other such issues that may invalidate the certificate.

Equipment marked for a specific gas, or marked for an equipment group plus a specific gas, and used in that specific gas atmosphere shall be installed in accordance with the requirements for the equipment group to which the specific gas belongs. For example, equipment marked "IIB + H_2" and used in a hydrogen atmosphere shall be installed as IIC equipment.

Aluminium conductors in Ex "d" flameproof enclosures should be avoided in those cases where a fault leading to potentially severe arcing involving the conductors may occur in the vicinity of a plain flanged joint. Adequate protection may be afforded by conductor and terminal insulation that prevents the occurrence of faults or by using enclosures with spigot or threaded joints.

14.2 Solid obstacles

When installing equipment, care shall be exercised to prevent the flameproof flange joint approaching nearer than the distance specified in Table 13 to any solid obstacle which is not part of the equipment, such as steelwork, walls, weather guards, mounting brackets, pipes or other electrical equipment, unless the equipment has been tested at a smaller distance of separation and has been documented.

Table 13 – Minimum distance of obstruction from the flameproof flange joints related to the gas group of the hazardous area

Gas group	Minimum distance mm
IIA	10
IIB	30
IIC	40

14.3 Protection of flameproof joints

Protection against corrosion of flameproof joints shall be maintained in accordance with the manufacturer's documentation. The use of gaskets is only permissible when specified in the manufacturer's documentation.

Flameproof joints shall not be painted.

Painting (by the user) of the enclosure after complete assembly is permitted, ensuring the electrostatic charging is avoided in accordance with 6.5.2. The application of grease to the flameproof joint faces will reduce, but not eliminate, the quantity of paint penetrating the gap.

The effect of the paint on the temperature rating of the enclosure should be taken into account. It should also be ensured that all markings remain readable.

Where the manufacturer's documentation does not address joint protection including use of grease then only corrosion inhibiting grease, such as petroleum jelly or soap-thickened mineral oils, may be applied to joint surfaces before assembly. The grease, if applied, shall be of a type that does not harden because of ageing, does not contain an evaporating solvent, and does not cause corrosion of the joint surfaces. Care in the selection and application of greases should be taken to ensure the retention of the non-setting characteristics and to allow subsequent separation of the joint surfaces.

NOTE 1 It is the user's responsibility to confirm the grease is suitable.

NOTE 2 If silicone based greases are used these can affect some types of gas detectors (see IEC 60079-29).

Where the enclosure is used in conjunction with gases allocated to Group IIC, tape shall not be applied.

Non-hardening grease-bearing textile tape may be employed outside of a straight flanged joint with the following conditions:

– where the enclosure is used in conjunction with gases allocated to Group IIA, the tape should be restricted to one layer surrounding all parts of the flange joint with a short overlap. New tape should be applied whenever existing tape is disturbed;
– where the enclosure is used in conjunction with gases allocated to Group IIB, the gap between the joint surfaces should not exceed 0,1 mm, irrespective of the flange width. The tape should be restricted to one layer surrounding all parts of the flange joint with a short overlap. New tape should be applied whenever existing tape is disturbed.

14.4 Conduit systems

Flameproof sealing devices for conduit shall be:

a) provided with the equipment and detailed in the equipment documentation; or
b) as specified in the equipment documentation; or
c) compliant with IEC 60079-1.

Conduit sealing devices shall be provided, either as part of the flameproof enclosure or immediately or as close as practical to the entry to the flameproof enclosure using a minimum number of fittings.

NOTE 1 The above includes a requirement to provide a seal between close coupled enclosures unless these are supplied as a certified assembly by the manufacturer.

Conduit sealing devices, having parallel threads may be fitted with a sealing washer between the device and the flameproof enclosure provided that after the washer has been fitted, the applicable thread engagement is still achieved. Thread engagement shall be at least five full threads. Suitable grease may be used provided it is non-setting and any earthing between the two is maintained.

A conduit sealing device is considered as fitted immediately at the entry of the flameproof enclosure when the device is fixed to the enclosure either directly or through an accessory necessary for coupling according to the manufacturer's instructions. The distance from the face of the seal closest to the enclosure (or intended end-use enclosure), and the outside wall of the enclosure (or intended end-use enclosure) should be as small as practical, but in no case more than the size of the conduit or 50 mm, whichever is the lesser.

NOTE 2 Gas or vapour leakage and propagation of flames may occur through the interstices between the strands of standard stranded conductors, or between individual cores of a cable. Special constructions can be employed as means of reducing leakage and preventing the propagation of flames. Examples include compacted strands, sealing of the individual strands, and extruded bedding. See also 9.3.2.

15 Additional requirements for type of protection "e" – Increased safety

15.1 General

Only Ex "e" equipment having a complete certificate shall be installed.

Ex "e" enclosures and components having only a component certificate, i.e. marked with a "U", shall not be installed in the hazardous area unless part of an assembly of components (now being referred to as an equipment) when the components in the equipment are permitted by a full Ex certificate which may contain an "X" and the equipment label carries full Ex marking including temperature class.

15.2 Maximum dissipated power of terminal box enclosures

Care shall be taken to ensure that the heat dissipated by the power loss within the enclosure does not result in temperatures in excess of the required equipment temperature class. This can be achieved by:

a) following the guidance given by the manufacturer relating to the permissible number of terminals, the conductor size and the maximum current, or

b) checking that the calculated dissipated power, using parameters specified by the manufacturer, is less than the rated maximum dissipated power.

The length of conductors should be kept as short as practicable as the basis of the calculations and type tests is that the conductor length is half the enclosure diagonal. Keeping the conductors short will ensure that on average the length does not exceed the basis of the type tests. Additional length of conductors inside the enclosure running at maximum permitted current may give rise to increased internal temperature that may exceed the temperature class.

Bunching of more than 6 conductors may also give rise to high temperatures that may exceed T6 and/or damage to the insulation and should be avoided.

The manufacturer's documentation shall comprise for each terminal size, the permissible number of terminals, the conductor size and the maximum current (see the example in Table 14).

Unless otherwise specified in the certificate:

– only Ex "e" terminals shall be included in the terminal box enclosure;

– no other components are allowed;

– only one conductor per one connecting point is allowed.

15.3 Conductor terminations

Some terminals, e.g. slot types, may permit the entry of more than one conductor. Where more than one conductor is connected to the same terminal, care shall be taken to ensure that each conductor is adequately clamped.

Unless permitted by the manufacturer's documentation, two conductors of different cross-sections shall not be connected into one terminal unless they are first secured with a single compression type ferrule or other method specified by the manufacturer.

To avoid the risk of short-circuits between adjacent conductors in terminal blocks, the insulation of each conductor shall be maintained up to the metal of the terminal.

Where single screw saddle clamps are used with a single conductor, the latter should be shaped around the screw in the form of a "U" unless clamping of single conductors without "U" is permitted in the documentation supplied with the equipment.

15.4 Maximum number of conductors in relation to the cross-section and the permissible continuous current

If more than one combination of values is possible, then the information may be given by the manufacturer in the form of a table. If combinations of different current values and or cross-sections are used, then a calculation should be made by the installer using the table. An example of a calculation is shown in Table 14. If not all terminals are loaded at the same time then a load factor may also be used for the calculation.

Table 14 – Example of defined terminal/conductor arrangement – Maximum number of wires in relation to the cross-section and the permissible continuous current

Current A	Conductors based on cross-section in mm²				
	1,5	2,5	4	6	
3					
6			a		
10	40				
16	13	26			
20	5	15	30		
25		7	17	33	
35			3	12	
50		b			
63					
Maximum number of terminals	20	13	15	16	

NOTE All incoming conductors and internal links count as conductors, earth connections do not count.

When using this table, the diversity factor or the rated load factor in accordance with IEC 61439 may be taken into consideration. Mixed sizes of conductors with circuits of different cross-sections and currents are possible when the table values are used in the respective proportions.

a Any number additionally.

b To be engineered by the manufacturer (with heat rise calculation).

Cross-section mm²	Current A	Quantity	=	Utilization
1,5	10	20 (of 40)	=	50 %
2,5	20	5 (of 15)	=	33,3 %
4	25	2 (of 17)	=	11,7 %
		Total < 100 %	=	95,0 %

16 Additional requirements for types of protection “i” – Intrinsic safety

16.1 General

A fundamentally different type of protection philosophy has to be recognized in the installation of intrinsically safe circuits. The integrity of an intrinsically safe circuit has to be protected from the intrusion of energy from other electrical sources so that the safe energy limitation in the circuit is not exceeded, even when breaking, shorting or earthing of the circuit occurs. The

principles apply equally to Group II and Group III intrinsically safe circuit of intrinsically safe apparatus and associated apparatus unless otherwise stated.

Associated apparatus should preferably be located outside the hazardous area or, if installed inside a hazardous area, shall be provided with another appropriate type of protection in accordance with Clause 5.

Where the properties of intrinsic safety can be impaired by ingress of moisture or dust or by access to conducting parts and in order to protect against unauthorized interference and damage, the components and internal wiring of intrinsically safe apparatus and associated apparatus (e.g. barriers) shall be mounted in a suitable enclosure. Alternative methods of mounting may be used if they offer similar integrity against interference and damage.

As a consequence of this principle, the aim of the installation rules for intrinsically safe circuits is to maintain separation from other circuits. Unless otherwise stated, requirements for intrinsically safe circuits shall apply to all levels of protection (“ia”, “ib” and “ic”).

The installation of energy-limited circuits “nL” shall comply with all the requirements for intrinsically safe circuits “ic”.

16.2 Installations to meet the requirements of EPL “Gb” or “Gc” and “Db” or “Dc”

16.2.1 Equipment

In installations to meet the requirements of EPL “Gb”, the intrinsically safe apparatus and the intrinsically safe parts of associated apparatus shall comply with IEC 60079-11, at least to level of protection “ib”.

In installations to meet the requirements of EPL “Gc”, the intrinsically safe apparatus and the intrinsically safe parts of associated apparatus shall comply with IEC 60079-11, at least to level of protection “ic”.

In installations to meet the requirements of EPL “Db”, the intrinsically safe apparatus and the intrinsically safe parts of associated apparatus shall comply with IEC 60079-11, for Group III at least to level of protection “ib”.

In installations to meet the requirements of EPL “Dc”, the intrinsically safe apparatus and the intrinsically safe parts of associated apparatus shall comply with IEC 60079-11, for Group III at least to level of protection “ic”.

Electrical equipment connected to the non-intrinsically safe terminals of an associated apparatus shall not be fed with a voltage supply greater than U_m shown on the label of the associated apparatus. The prospective short-circuit current of the supply shall not be greater than 1 500 A.

Limitation of the prospective short-circuit current, where higher fault levels exist, may be achieved by appropriate upstream fusing or protection.

Where U_m marked on the associated apparatus is less than 250 V it shall be installed in accordance with one of the following:

a) where U_m does not exceed 50 V a.c. or 120 V d.c., in a SELV or PELV system, or

b) via a safety isolating transformer complying with the requirements of IEC 61558-2-6, or technically equivalent standard, or

c) directly connected to apparatus complying with the IEC 60950 series, IEC 61010-1, or a technically equivalent standard, or

d) fed directly from cells or batteries.

All apparatus forming part of an intrinsically safe system should, where reasonably practicable, be identifiable as being part of an intrinsically safe system. See also 16.2.2.6 for marking of cables.

16.2.2 Cables

16.2.2.1 General

AC1 Only cables with insulation capable of withstanding a dielectric test of twice the voltage of the intrinsically safe circuit or 500 V r.m.s. (750 V d.c.), whichever is the greater, shall be used in intrinsically safe circuits. AC1

The diameter of individual conductors or strands of multi-stranded conductors within the hazardous area shall be not less than 0,1 mm.

16.2.2.2 Electrical parameters of cables

The electrical parameters (C_c and L_c) or (C_c and L_c/R_c) for all cables used shall be determined according to a), b) or c):

a) the most onerous electrical parameters provided by the cable manufacturer;

b) electrical parameters determined by measurement of a sample;

NOTE Annex H details a satisfactory method of determining the relevant parameters.

c) 200 pF/m and either 1 μH/m or 30 μH/Ω where the interconnection comprises two or three cores of a conventionally constructed cable (with or without screen).

Where a FISCO or FNICO system is used, the requirements for cable parameters shall comply with IEC 60079-25.

16.2.2.3 Earthing of conducting screens

Where a screen is required, except as in a) through c) below, the screen shall be electrically connected to earth at one point only, normally at the non-hazardous area end of the circuit loop. This requirement is to avoid the possibility of the screen carrying a possibly incendive level of circulating current in the event that there are local differences in earth potential between points that may be available for connection to earth.

If an earthed intrinsically safe circuit is run in a screened cable, the screen for that circuit shall be earthed at the same point as the intrinsically safe circuit which it is screening.

If an intrinsically safe circuit or sub-circuit which is isolated from earth is run in a screened cable, the screen shall be connected to the equipotential bonding system at one point.

Special cases:

a) If there are special reasons (for example when the screen has high resistance, or where screening against inductive interference is additionally required) for the screen to have multiple electrical connections throughout its length, the arrangement of Figure 2 may be used, provided that

   – the insulated earth conductor is of robust construction (normally at least 4 mm^2 but 16 mm^2 may be more appropriate for clamp type connections);

   – the arrangement of the insulated earth conductor plus the screen are insulated to withstand a 500 V a.c. rms or 700 V d.c. as applicable insulation test from all other conductors in the cable and any cable armour;

   – the insulated earth conductor and the screen are only connected to earth at one point which shall be the same point for both the insulated earth conductor and the screen, and would normally be at the non-hazardous end of the cable;

   – the insulated earth conductor complies with 9.3.7;

– the inductance/resistance ratio (L/R) of the cable, installed together with the insulated earth conductor, shall be established and shown to conform to the requirements of 16.2.2.5.

b) If the installation is effected and maintained in such a manner that there is a high level of assurance that potential equalization exists between each end of the circuit (i.e. between the hazardous area and the non-hazardous area), then, if desired, cable screens may be connected to earth at both ends of the cable and, if required, at any interposing points.

c) Multiple earthing through small capacitors (for example 1 nF, 1 500 V ceramic) is acceptable provided that the total capacitance does not exceed 10 nF.

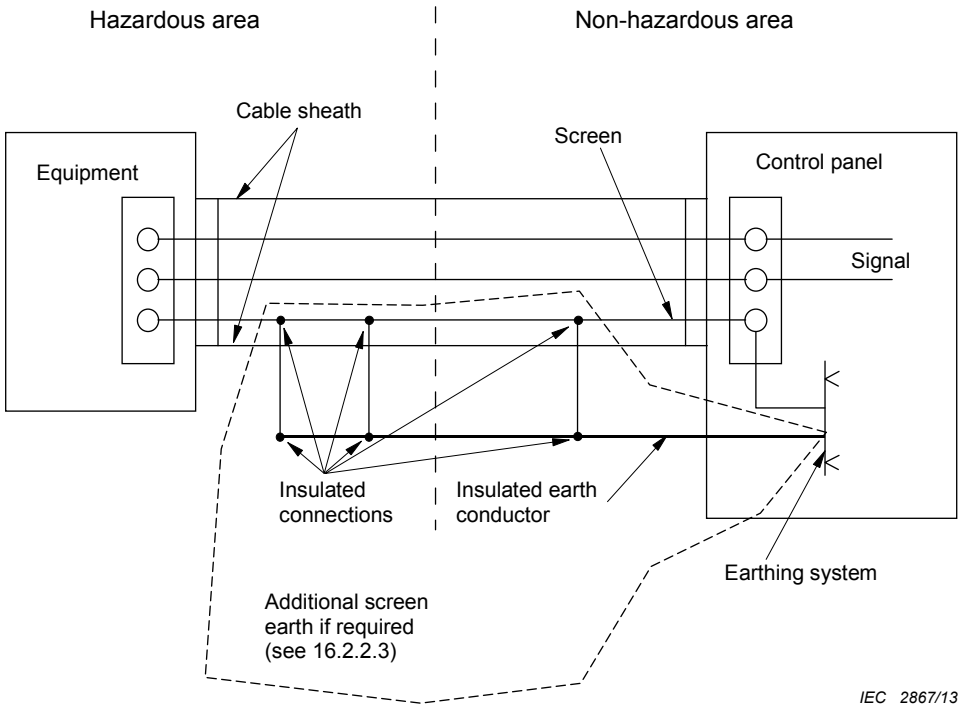

Figure 2 – Earthing of conducting screens

16.2.2.4 Cable armour bonding

The armour shall be bonded to the equipotential bonding system via the cable entry devices or equivalent, at each end of the cable run. Where there are interposing junction boxes or other equipment, the armour will normally be similarly bonded to the equipotential bonding system at these points. In the event that armour is required not to be bonded to the equipotential bonding system at any interposing point, care shall be taken to ensure that the electrical continuity of the armour from end to end of the complete cable run is maintained.

Where bonding of the armour at a cable entry point is not practical, or where design requirements make this not permissible, care shall be taken to avoid any potential difference which may arise between the armour and the equipotential bonding system giving rise to an incendive spark. In any event, there shall be at least one electrical bonding connection of the armour to the equipotential bonding system. The cable entry device for isolating the armour from earth shall be installed in the non-hazardous area or locations requiring EPL “Gc” or “Dc”.

16.2.2.5 Installation of cables and wiring

16.2.2.5.1 General

Installations with intrinsically safe circuits shall be erected in such a way that their intrinsic safety is not adversely affected by external electric or magnetic fields such as from nearby

power lines or heavy current-carrying single core cables. This can be achieved, for example, by the use of screens and/or twisted cores or by maintaining an adequate distance from the source of the electric or magnetic field.

In addition to the cable requirements of 9.3.7, cables in both hazardous and non-hazardous areas shall be installed so as to ensure that intrinsically safe circuit cables cannot be inadvertently connected to circuit cables which are not intrinsically safe. This may be achieved by:

a) separating the different types of circuit cables, or

b) placing the cables so as to protect against the risk of mechanical damage (see also 9.3.7), or

c) using cables which are armoured, metal sheathed or screened for at least one type of circuit (e.g. all circuits which are not intrinsically safe are run in armoured cable or all intrinsically safe circuits are armoured).

16.2.2.5.2 Conductors

Conductors of intrinsically safe circuits shall not be carried in the same cable as conductors of circuits which are not intrinsically safe except as permitted by 16.6.

Conductors of intrinsically safe circuits, except as permitted by 16.2.2.7, shall not be in the same bundle or duct as conductors of circuits which are not intrinsically safe unless separated by an intermediate layer of insulating material or by an earthed metal partition. No separation is required if metal sheaths or screens are used for the intrinsically safe circuits or the circuits which are not intrinsically safe.

16.2.2.5.3 Unused cores in cables

Each unused core in a cable shall either

a) be adequately insulated from earth and from each other at both ends by the use of suitable terminations, or

b) if other circuits in the cable have an earth connection (e.g. via the associated apparatus), be connected to the earth point used to earth any intrinsically safe circuits in the same cable, but shall be adequately insulated from earth and from each other by the use of suitable terminations at the other end.

NOTE The use of heat-shrink tubing or terminating the unused core in suitable terminals would satisfy the requirements of 16.2.2.5.3.

16.2.2.6 Marking of cables

Cables containing intrinsically safe circuits shall be marked (except as below) to identify them as being a part of an intrinsically safe circuit. If sheaths or coverings are marked by a colour, the colour used for cables containing intrinsically safe circuits shall be light blue. Where intrinsically safe circuits have been identified by the use of light blue covered cable, then light blue covered cable shall not be used for other purposes in a manner or location which could lead to confusion or detract from the effectiveness of the identification of intrinsically safe circuits.

If all intrinsically safe circuit cables or all cables of circuits which are not intrinsically safe are armoured, metal sheathed or screened, then marking of intrinsically safe circuit cables is not required.

Alternative marking measures shall be taken inside measuring and control cabinets, switchgear, distribution equipment, etc. where there is a risk of confusion between cables of intrinsically safe and non-intrinsically safe circuits, in the presence of a blue neutral conductor. Such measures include:

– combining the cores in a common light blue harness;
– labelling;
– clear arrangement and spatial separation.

16.2.2.7 Cables carrying more than one intrinsically safe circuit

The requirements of 16.2.2.7 are in addition to those of 16.2.2.1 to 16.2.2.6.

Cables may contain more than one intrinsically safe circuit. Circuits which are not intrinsically safe shall not be carried in the same cables with intrinsically safe circuits except as noted in 16.6. Intrinsically safe “ic” circuits are permitted to be run together with intrinsically safe “ia” and “ib” circuits provided they are run in a cable of Type A or Type B as specified in 16.2.2.8.

The radial thickness of the conductor insulation shall be appropriate to the conductor diameter and the nature of the insulation. The minimum radial thickness shall be at least 0,2 mm.

Cables shall be of a type with the conductor insulation capable of withstanding a dielectric test of at least

– 500 V r.m.s. a.c. or 700 V d.c. applied between any armouring and/or screen(s) joined together and all the conductors joined together;
– 1 000 V r.m.s. a.c. or 1 400 V d.c. applied between a bundle comprising one half of the cable conductors joined together and a bundle comprising the other half of the conductors joined together. This test is not applicable to cables carrying more than one intrinsically safe circuit with conducting screens for individual circuits.

The dielectric strength tests shall be carried out by a method specified in an appropriate cable standard. Where no such method is available, the tests shall be carried out in accordance with the dielectric strength tests specified in IEC 60079-11.

NOTE The above requirement can be satisfied by providing evidence of testing from the cable supplier or manufacturer, or by the installer.

16.2.2.8 Types of cables carrying more than one intrinsically safe circuit and applicable fault considerations

The faults, if any, which shall be taken into consideration in cables carrying more than one intrinsically safe circuit used in intrinsically safe electrical systems depend upon the type of cable used.

– Type A

  For cables complying with the requirements of 16.2.2.7 and, in addition, with conducting screens providing individual protection for intrinsically safe circuits in order to prevent such circuits becoming connected to one another, coverage of such screens shall be at least 60 % of the surface area; no faults between circuits are taken into consideration.

– Type B

  Cable which is fixed, effectively protected against damage, complying with the requirements of 16.2.2.7 and, in addition, no circuit contained within the cable has a maximum voltage U_o exceeding 60 V; no faults between circuits are taken into consideration.

– Type C

  For cables complying with the requirements of 16.2.2.7 but not the additional requirements of Type A or Type B, it is necessary for “ia” or “ib” to take into consideration up to two short-circuits between conductors and, simultaneously, up to four open circuits of conductors. In the case of identical circuits, failures need not be taken into consideration provided that each circuit passing through the cable has a safety factor for spark ignition parameters of four times that required for level of protection “ia” or “ib”.

16.2.3 Earthing of intrinsically safe circuits

Intrinsically safe circuits shall be either

a) isolated from earth, or

b) connected at one point to the equipotential bonding system if this exists over the whole area in which the intrinsically safe circuits are installed.

The installation method shall be chosen with regard to the functional requirements of the circuits and in accordance with the manufacturer's instructions.

More than one earth connection is permitted on a circuit, provided that the circuit is galvanically separated into sub-circuits, each of which has only one earth point.

In intrinsically safe circuits which are isolated from earth, attention shall be paid to the danger of electrostatic charging. A connection to earth across a resistance greater than 0,2 MΩ for example for the dissipation of electrostatic charges, is not deemed to be earthing.

Intrinsically safe circuits shall be earthed if this is necessary for safety reasons, for example in installations with safety barriers without galvanic isolation. They may be earthed if necessary for functional reasons, for example with welded thermocouples. If the intrinsically safe apparatus does not withstand the electrical strength test with at least 500 V a.c. r.m.s. to earth according to IEC 60079-11, a connection to earth for the equipment is to be assumed.

Where the equipment is earthed (e.g. by the method of mounting) and a bonding conductor is used between the equipment and the point of earth connection of the associated apparatus, conformity with a) or b) is not required. Such situations should receive careful consideration by a competent person so as to avoid danger from circulating fault currents. Particular care should be taken where the requirements of EPL “Ga” apparatus have to be met. If bonding conductors are employed, they should be adequate for the situation, have a copper cross-sectional area of no less than 4 mm^2, be permanently installed without the use of plugs and sockets, adequately mechanically protected, and have terminals which conform to the requirements of type of protection “e” with the exception of the IP rating.

In intrinsically safe circuits, the earthing terminals of safety barriers without galvanic isolation (for example Zener barriers) shall be:

1) connected to the equipotential bonding system by the shortest practicable route, or

2) for TN-S systems only, connected to a high-integrity earth point in such a way as to ensure that the impedance from the point of connection to the main power system earth point is less than 1 Ω. This may be achieved by connection to a switch-room earth bar or by the use of separate earth rods.

The conductor used shall be insulated to prevent invasion of the earth by fault currents which might flow in metallic parts with which the conductor could come into contact (for example control panel frames). Mechanical protection shall also be provided in places where the risk of damage is high.

The cross-section of the earth connection shall consist of

- at least two separate conductors each rated to carry the maximum possible current, which can continuously flow, each with a minimum of 1,5 mm^2 copper, or
- at least one conductor with a minimum of 4 mm^2 copper.

The provision of two earthing conductors should be considered to facilitate testing.

If the prospective short-circuit current of the supply system connected to the barrier input terminals is such that the earth connection is not capable of carrying such current, then the cross-sectional area shall be increased accordingly or additional conductors used.