



شرکت ملی گاز ایران
مدیریت پژوهش و فناوری
امور تدوین استانداردها

IGS

مشخصات فنی خرید

لوله های غلاف برقی برای سیمهای برق

Conduits



تاریخ ۱۳۹۳/۶/۲۹
شماره گ.دب/۰-۲۱۳/۰-۱۷۰۸۷



دفتر مدیرعامل



ابلاغ مصوبه هیأت مدیره



مدیر محترم پژوهش و فناوری

باسلام،

به استحضار می‌رساند در جلسه ۱۵۹۴ مورخ ۱۳۹۳/۴/۲۹ هیأت مدیره، نامه شماره گ.۰۶۲۵۸/۰۰۰/۹ مورخ ۱۳۹۳/۴/۲۲ مدیر پژوهش و فناوری و رئیس شورای استاندارد در مورد تصویب نهایی استاندارد تحت عنوان لوله های غلاف برقی برای سیم های برق به شماره استاندارد (1) IGS-M-EL-001 مطرح و مورد تصویب قرار گرفت.

ناصر آبگون
دبیر هیأت مدیره

رونوشت: مدیرعامل محترم شرکت ملی گاز ایران و نایب رئیس هیأت مدیره

: معاون محترم مدیرعامل

: اعضای محترم هیأت مدیره

: مشاور عالی محترم مدیرعامل

: مدیر محترم گازرسانی

: مدیر محترم توسعه منابع انسانی

: سربازرس محترم (سازمان بازرسی کل کشور) مستقر در ستاد

: مدیرعامل محترم شرکت انتقال گاز ایران

: رئیس کل محترم امور حسابرسی داخلی

: رئیس محترم امور حقوقی

: رئیس محترم امور مجامع



FOREWORD

This standard is intended to be mainly used by NIGC and contractors, and has been prepared based on interpretation of recognized standards, technical documents, knowledge, backgrounds and experiences in natural gas industry at national and international levels.

Iranian Gas Standards (IGS) are prepared, reviewed and amended by technical standard committees within NIGC Standardization division and submitted to the NIGC's "STANDARDS COUNCIL" for approval.

IGS Standards are subject to revision, amendment or withdrawal, if required. Thus the latest edition of IGS shall be checked/inquired by NIGC employees and contractors.

This standard must not be modified or altered by NIGC employees or its contractors. Any deviation from normative references and / or well-known manufacturer's specifications must be reported to Standardization division.

The technical standard committee welcomes comments and feedbacks about this standard, and may revise this document accordingly based on the received feedbacks.

GENERAL DEFINITIONS:

Throughout this standard the following definitions, where applicable, should be followed:

- 1- "STANDARDIZATION DIV." is organized to deal with all aspects of industry standards in NIGC. Therefore, all enquiries for clarification or amendments are requested to be directed to mentioned division.
- 2- "COMPANY": refers to National Iranian Gas Company (NIGC).
- 3- "SUPPLIER": refers to a firm who will supply the service, equipment or material to NIGC whether as the prime producer or manufacturer or a trading firm.
- 4- "SHALL ": is used where a provision is mandatory.
- 5- "SHOULD": is used where a provision is advised only.
- 6- "MAY": is used where a provision is completely discretionary.

Website: <http://igs.nigc.ir>

E-mail: igs@nigc.ir

CONTENTS	PAGE
1. SCOPE	2
2. NORMATIVE REFERENCES	2
3. DEFINITIONS	2
4. GENERAL REQUIREMENTS	4
5. GENERAL CONDITIONS FOR TESTS	4
6. CLASSIFICATIONS	5
7. MARKING AND DOCUMENTATION	8
8. DIMENSIONS	9
9. CONSTRUCTIONS	10
10. MECHANICAL PROPERTIES	11
11. ELECTRICAL PROPERTIES	21
12. THERMAL PROPERTIES	24
13. FIRE EFFECTS	29
14. EXTERNAL INFLUENCES	29
15. ELECTROMAGNETIC COMPATIBILITY	31
ANNEX A – Classification Coding for Conduit Systems	32

1. SCOPE

This standard specifies requirements and tests for conduit systems, including conduits and conduit fittings, for the protection and management of insulated conductors and/or cables in electrical installations or in communication systems up to 1000 V a.c. and/or 1500 V d.c. This standard applies to metallic, non-metallic and composite conduit systems (rigid conduit systems) including threaded and non-threaded entries which terminate the system. This standard does not apply to enclosures and connecting boxes which come within the scope of IEC 60670.

Note 1: Certain conduit systems may also be suitable for use in hazardous atmospheres According to: IPS-M-EL-161. Regard should then be taken of the extra requirements necessary for equipment to be installed in such conditions

Note 2: Earthing conductors may or may not be insulated.

2. NORMATIVE REFERENCES

This Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

BS EN 50086-1 & 2 "Conduit systems for electrical installation"

3. DEFINITIONS

For the purposes of this standard, the following definitions apply.

3.1 Conduit System

A closed wiring system consisting of conduits and conduit fittings for the protection and management of insulated conductors and/or cables in electrical or communication installations, allowing them to be drawn in and/or replaced, but not inserted laterally.

3.2 Conduit

A part of a closed wiring system of general circular cross-section for insulated conductors and/or cables in electrical or communication installations, allowing them to be drawn in and/or replaced.

3.3 Conduit Fitting

A device designed to join or terminate one or more components of a conduit system, or change direction.

3.4 Metallic Conduit and /or Conduit Fitting

Conduit or conduit fitting which consists of metal only.

3.5 Non-Metallic Conduit and/or Conduit Fitting

Conduit or conduit fitting which consists uniquely of non-metallic material and has no metallic components whatsoever.

3.6 Composite Conduit and/or Conduit Fitting

Conduit or conduit fitting comprising both metallic and non-metallic materials.

3.7 Non-Flame Propagating Conduit and/or Conduit

Fitting conduit or conduit fitting which is liable to catch fire as a result of an applied flame, in which the flame does not propagate and which extinguishes itself within a limited time after the flame is removed.

3.8 Plain Conduit

A conduit in which the profile is even in the longitudinal section (see note 3.9).

3.9 Corrugated Conduit

A conduit in which the profile is corrugated in the longitudinal section.

Note: Both annular and helical corrugated conduits are permissible and a combination of both corrugated and plain conduit is possible.

3.10 Rigid Conduit

A conduit which cannot be bent, or only be bent with the help of a mechanical aid and with or without special treatment.

3.11 Pliable Conduit

A conduit which can be bent by hand, with a reasonable force and is not intended for frequent flexing.

3.12 Self-Recovering Conduit

A pliable conduit which deforms when a transverse force is applied for a short time and which after removal of this force returns close to its original shape within a further short time.

3.13 Material Thickness of a Plain Conduit

The average difference between the outside and inside diameter divided by two.

3.14 Material Thickness of a Corrugated Conduit

The average thickness of material measured at any point along the shape of one corrugation.

3.15 Material Thickness of a Combined Plain and Corrugated Conduit

The sum of the plain conduit material thickness and the corrugated material thickness.

3.16 Threadable Conduit and Conduit Fitting

Conduit and conduit fitting which carry a thread for connection; or in or on which a thread, can be formed.

3.17 Non-Threadable Conduit and Conduit Fitting

Conduit and conduit fitting which are suitable for connection only by means other than threads.

3.18 Conduit Joint

An interface between two or more components of a conduit system, or between a conduit system and other equipment

3.19 External Influence

Factors which may affect the conduit system.

Note: Examples of such factors are a presence of water, oil or building materials, low and high temperatures and corrosive or polluting substances.

3.20 Hot Dip Galvanizing

A coating of zinc and zinc-iron alloy layers, obtained by dipping prepared iron or steel articles in molten zinc.

Note: Under some circumstances the whole coating may consist of zinc-alloy layers.

3.21 Sherardizing

A diffusion process in which articles are heated in close contact with zinc dust and inert operating media.

Note: The process is normally carried out in a slowly rotating closed container at a temperature in the region of 385 °C. The corrosion resistance is proportional to the coating thickness which can be controlled.

4. GENERAL REQUIREMENTS

4.1 Conduit and conduit fittings within the scope of This standard shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings. When assembled in accordance with manufacturer's instructions as part of a conduit system, they shall provide mechanical and, where required, electrical protection of the insulated conductors and cables contained therein.

4.2 The protective properties of the joint between the conduit and conduit fitting shall be not less than that declared for the conduit system.

4.3 Conduit and conduit fittings shall withstand the stresses likely to occur during transport, storage, recommended installation practice and application.

5. GENERAL CONDITIONS FOR TESTS

5.1 Tests in accordance with this standard are type tests.

5.2 Unless otherwise specified, the tests shall be carried out at an ambient temperature of (23 ± 2) °C.

5.3 Unless otherwise specified each test shall be made on three new samples.

Note: Certain tests, for instance the checking of dimensions, do not affect a change in the property of the samples and therefore these samples are considered as new samples and can be used for further tests.

5.4 Samples of non-metallic and composite conduits and conduit fittings shall be conditioned for at least 240 h., at a temperature of (23 ± 2) °C and a relative humidity between 40 % and 60 %. All tests shall be carried out immediately after general conditioning.

5.5 Unless otherwise specified, the samples for each test shall be in a clean and new condition, with all parts in place and mounted as in normal use. After checking dimensions in accordance with clause 8, and unless otherwise specified in the relevant test, the conduit fittings shall be assembled with adequate lengths of conduit of the type for which they are intended. Due regard shall be taken of the manufacturer's instructions, especially where force is required in the assembly of the joint.

5.6 Where the conduit entries are part of the detachable or loose type conduit fitting, the detachable conduit fitting shall be capable of being assembled again, after the test, according to the manufacturer's instructions without loss of the declared properties according to clause 6.

5.7 Unless otherwise specified, three samples are submitted to the tests and the requirements are satisfied if the tests are met. If only one of the samples does not satisfy a test due to an assembly or a manufacturing defect that test and any preceding one which may have influenced the result of the test shall be repeated and also the tests which follow shall be made in the required sequence on another full set of samples, all of which shall comply with the requirements. If the additional set of samples is not submitted at the same time, a failure of one sample will entail a rejection.

Note: The applicant when submitting the first set of samples, may also submit the additional set of samples which may be necessary, should one sample fail. The testing station will then without further request test the additional set of samples and will reject only if a further failure occurs.

5.8 When toxic or hazardous processes are used, due regard shall be taken of the safety of the persons within the test area.

5.9 Conduit systems which are used as an integral part of other equipment shall also be tested in accordance with the relevant standard for that equipment.

6. CLASSIFICATIONS

Note: Annex A shows the classification coding format for declared properties of the conduit system, which may be incorporated in the manufacturer's literature.

6.1 According to Mechanical Properties

6.1.1 Resistance to compression:

- 1-Very light
- 2-Light
- 3-Medium
- 4 -Heavy
- 5 -Very heavy

6.1.2 Resistance to impact:

- 1-Very light
- 2-Light
- 3-Medium
- 4-Heavy
- 5-Very heavy

6.1.3 Resistance to bending:

- 1-Rigid
- 2-Pliable
- 3-Pliable/Self-recovering
- 4-Flexible

6.1.4 Tensile strength:

- 1-Very light
- 2-Light
- 3-Medium
- 4-Heavy
- 5-Very heavy

6.1.5 Suspended load capacity:

- 1-Very light
- 2-Light
- 3-Medium
- 4-Heavy
- 5-Very heavy

6.2 According to Temperature:

6.2.1 Lower temperature range

Table 1 – Lower Temperature Range

Classification (1st Numeral)	Transport, Permanent Application & Installation not less than °C
1x	+5
2x	-5
3x	-15
4x	-25
5x	-45

6.2.2 Upper temperature range

Table 2 – Upper Temperature Range

Classification (2st Numeral)	Permanent Application & Installation not more than °C
X1	60
X2	90
X3	105
X4	120
X5	150
X6	250
X7	400

6.3 According to Electrical Characteristics:

6.3.1 With electrical continuity characteristics

6.3.2 With electrical insulating characteristics

6.4 According to Resistance to External Influences

6.4.1 Protection against ingress of solid objects:
With protection in accordance with EN 60529 to minimum of IP3X

6.4.2 Protection against ingress of water:
With protection in accordance with EN 60529 to a minimum of IPXO

6.4.3 Resistance against corrosion:

- 1- Without protection
- 2- With protection as detailed in Table 14

6.5 According to Resistance to Flame Propagation:

6.5.1 Non-flame propagating

6.5.2 Flame propagating

6.5.3 Other fire effects under consideration.

7. MARKING AND DOCUMENTATION

7.1 The conduit shall be marked on the product with:

- a) The name or trademark of the manufacturer, or responsible vendor;
- b) A product identification mark.

7.1.1 The conduit may also be marked with the classification code which shall be in accordance with Annex A and shall include at least the first four digits.

Note 1: The conduit shall be marked in accordance with 7.1 at regular intervals along its length of preferably 1 m but not longer than 3 m and each length shall be marked at least once.

Note 2: The manufacturer shall document for the system the minimum inside diameter and the classification in accordance with clause 6.

7.1.2 The manufacturer shall be responsible for indicating the compatibility of parts within a conduit system.

7.2 The conduit fitting shall be marked in accordance with 7.1.1, on the product wherever possible but where this is impractical then the mark may be on a label attached to the product or to the box or carton containing the fittings

7.3 Flame propagating material shall be orange in color. It shall not be colored orange by painting or other superficial means. Non-flame propagating material may be of any color except yellow, orange or red, unless clearly marked on the product to be of non-flame propagating material.

7.4 Earthing facility shall be indicated by the Symbol for protective earth in accordance with HD 243 S10, symbol IEC60417-5019a. This marking shall not be placed on easily removable parts, e.g. screws.

7.5 The marking shall be durable and easily legible. Compliance shall be checked by inspection and by rubbing the marking by hand for 15s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

Note 1: Petroleum spirit is defined as the aliphatic solvent hexane with a content of aromatics of maximum 0, 1 %, volume, a kauri- butanol value of 29, initial boiling point 65 °C, a dry point 69 °C and specific gravity 0, 68 kg/l.

Note 2: Marking may be applied, for example, by molding, pressing, engraving, printing, adhesive labels, or water slide transfers.

Note 3: Marking made by molding, pressing or engraving is not subjected to this test. After the test the marking shall be legible.

7.6 The conduit shall be marked in accordance with 7.1 at regular intervals along its length of preferably 1 m but not longer than 3 m and each length shall be marked at least once. Compliances checked by inspection.

7.7 The manufacturer shall document for the system the minimum inside diameter and the classification in accordance with clause 6. Compliance is checked by inspection.

8. DIMENSIONS

8.1 Threads and outside diameters shall comply with Table 1 EN 60423. Compliance is checked by means of the gauges specified in table 2 EN60423.

8.2 Threadable conduits and threadable conduit fittings shall comply with Table 3. Non-threadable conduit fittings shall comply with Table 4. The minimum inside diameter of the conduit system shall be declared by the manufacturer. Compliances checked by measurement.

Table 3 – Thread Lengths

Size	External Thread	Internal Thread
	Minimum Length (mm)	Minimum Length (mm)
6	05.5	06.5
8	06.5	07.5
10	08.5	09.5
12	10.5	11.5
16	12.5	13.5
20	14.0	15.0
25	17.0	18.0
32	19.0	20.0
40	19.0	20.0
50	19.0	20.0
63	19.0	20.0
75	19.0	20.0

Table 4 – Maximum entry Diameter and Minimum Entry Length Details

Size	Maximum Entry Diameter (mm)	Minimum Entry Diameter (mm)
6	06.5	06.0
8	08.5	08.0
10	10.5	10.0
12	12.5	12.0
16	16.5	16.0
20	20.5	20.0
25	25.5	25.0
32	32.6	30.0
40	40.7	32.0
50	50.8	42.0
63	63.9	50.0
75	75.9	50.0

9. CONSTRUCTIONS

9.1 Within the conduit system there shall be no sharp edges, burrs or surface projections which are likely to damage insulated conductors or cables or inflict injury to the installer or user. The manufacturer shall be responsible for providing guidelines to assist the safe installation of the conduit system. Compliance is checked by inspection, if necessary after cutting the samples apart.

9.2 Screws, if any, used for attaching components or covers to conduit fittings, or in joints to conduits shall not cause damage to cable insulation when correctly inserted. They shall have ISO metric threads. Thread cutting screws shall not be used. Fixing screws and small clips for use with non-metallic or composite conduit fittings need not be of non-metallic material if they are isolated from insulated conductors or cables. Screw fixing means shall be so designed to withstand the mechanical stresses occurring during installation and normal use. Compliance for screw fix inquiring preformed Threads is checked by the test in 9.3 followed by inspection. Compliance for screw fixing using thread-forming screws is checked by the test in 9.4, followed by inspection.

9.3 Screws used with preformed threads shall be tightened and loosened ten times for screws in engagement with a thread of non-metallic material and for screws of non-metallic material, and five times in all other cases. The test shall be made by using a suitable screwdriver or spanner applying a torque in accordance with Table 5. The screws shall not be tightened by sudden or jerky motions. After the test, there shall be no damage sustained by the screw or nut such as breakage of the screw or damage to the head or threads that will impair the further use of the screw or nut.

Table 5 – Torque Values for Screw Tests

Nominal Diameter of Thread mm		Torque Nm	
Over	Up to & including	I	II
-	2.8	0.4	0.4
2.8	3.0	0.5	0.5
3.0	3.2	0.6	0.6
3.2	3.6	0.8	0.8
3.6	4.1	1.2	1.2
4.1	4.7	1.8	1.8
4.7	5.3	2.0	2.0
5.3	6.0	2.5	3.0
6.0	8.0	3.5	6.0
8.0	10.0	4.0	10.0

Note 1: Column I applies to screws are tightened by means of a screwdriver
Note 2: Column II applies to screws and nuts which area tightened by means other than a screwdriver

9.4 Thread-forming screws are tightened and loosened ten times for screws in engagement with a thread of insulating material and five times in all other cases. Screws in engagement with a thread of insulating material shall be completely removed each time. The test is made by using a suitable screwdriver or spanner applying a torque in accordance with Table 5. The screw shall not be tightened by sudden or jerky motions. After the test, there shall be no damage such as breakage of the screw or damage to the head or thread that will impair the further use of the screw.

9.5 Any material, for example rubber, fiber etc., within the joint which may be exposed to external influences when assembled according to the manufacturer's instructions shall have at least the same level of resistance to the external influence as either the conduit or the conduit fitting. Compliances checked by means of tests specified in clause 14.

9.6 For conduit systems that are assembled by means other than threads the manufacturer shall indicate whether the system can be disassembled and if, how it can be achieved. Compliance is checked by inspection and by manual Test.

10. MECHANICAL PROPERTIES

10.1 Metal Conduit

Conduit shall be steel, galvanized in and out with high protection, heavy gauge, and solid drawn, seamless, threaded to metric threads of ISO form, with one coupling per length and approximately 4 meters long. Preferred sizes are given in Table 6.

Table 6 – Preferred Sizes

Size mm	Wall Thickness mm	Length of Thread mm	Run out of Thread mm
16	1.4=0.15	13	3
20	1.5=0.15	13	3
25	1.6=0.15	13	3
32	1.6=0.15	15	3
40	1.6=0.15	19	3
50	1.6=0.15	19	3
63	1.8=0.15	19	3

10.2 Mechanical Strength

10.2.1 Conduit systems shall have adequate mechanical strength.

10.2.2 Conduits according to their classification, when bent or compressed, or exposed to impact or extreme temperature, of a specified value in accordance with impact and temperature classification declared for the product, either during, or after, installation according to the manufacturer's instructions, shall not crack and shall not be deformed to such an extent that introduction of the insulated conductors or cables becomes difficult, or that the installed insulated conductors or cables are likely to be damaged, while being drawn in.

10.2.3 Conduit systems intended as a mounting for other equipment shall have adequate mechanical strength to support such equipment and to withstand the force required to operate the equipment, both during and after installation.

10.2.4 Compliance is checked by the tests specified in 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 and 10.8.

10.3 Compression Test

10.3.1 Samples of conduit each (200 ± 5) mm long, shall be subjected to a compression test, using the apparatus shown in Figure 1.

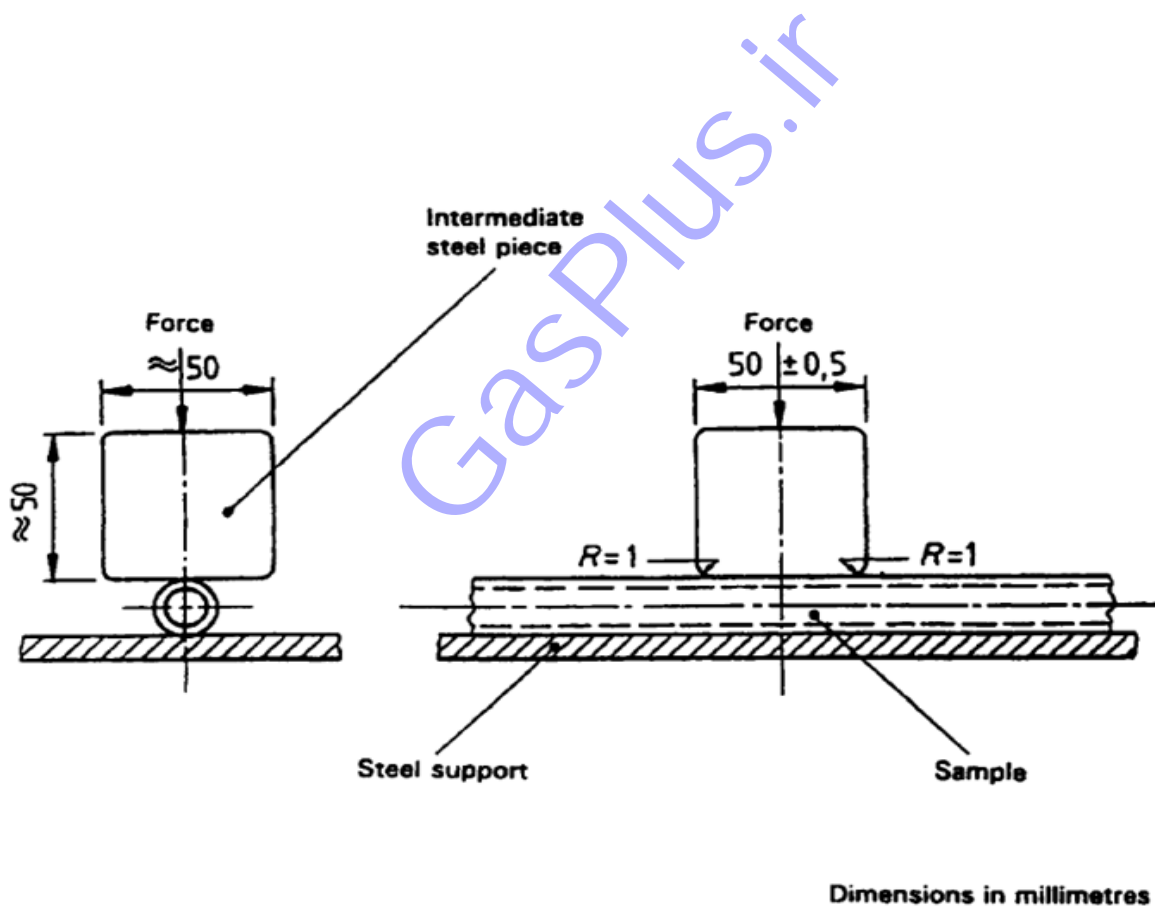


Figure 1 – Arrangement for Compression Test

10.3.2 Before the test the outside diameters of the samples shall be measured.

10.3.3 The samples shall be positioned on a flat steel support, and a steel intermediate piece, as shown in Figure 1, shall be placed in the middle of the sample.

10.3.4 A constantly increasing compression force, reaching the values shown in Table 7, within 30 s, shall be applied to the intermediate piece.

10.3.5 After the force shown in Table 7 has been applied for (60 ± 2) s, the outside diameter of the sample shall be measured where flattening has taken place, without removing the force.

Table 7 – Compression Force

Classification	Conduits	Compression Force [N] +4% - 0%
1	Very light	125
2	Light	320
3	Medium	750
4	Heavy	1250
5	Very heavy	4000

10.3.6 The difference between the initial outside diameter and the diameter of the flattened sample shall not exceed 25 % of the initial outside diameter measured before the test.

10.3.7 The force and the intermediate piece are then removed and, 60 s after removal, the outside diameter of the samples, where they have flattened, shall be measured again. The difference between the initial diameter and the diameter of the flattened samples shall not exceed 10 % of the outside diameter, measured before the test.

10.3.8 After the test, the samples shall show no cracks visible to normal or corrected vision without additional magnification.

10.4 Impact Test

10.4.1 Twelve samples of conduit each (200 ± 5) mm in length or twelve conduit fittings are subjected to an impact test by means of the apparatus shown in Figure 2.

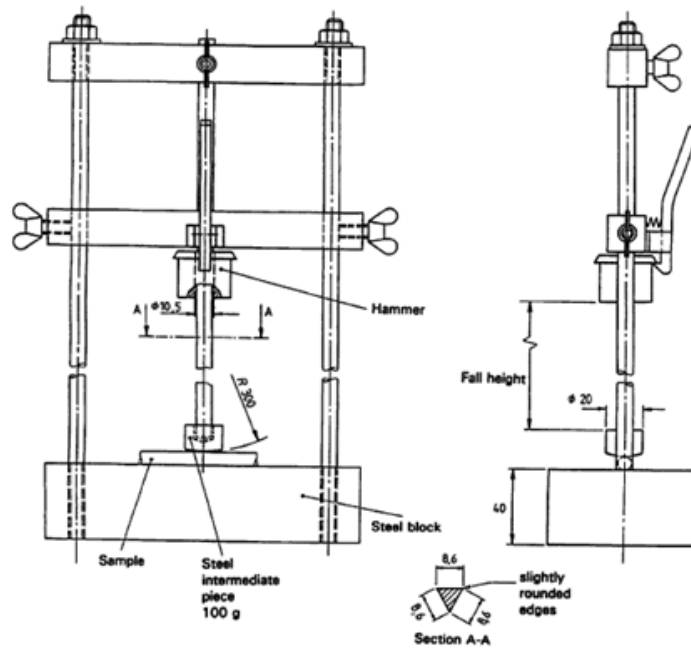


Figure 2 – Impact-Test Apparatus

Before the test, the samples are assembled with all the components as for normal use, including conduits required for conducting of the test.

Note: Fittings are not required when testing conduit. Parts which are not accessible when mounted in normal use and small conduit fittings whose maximum dimension is less than 20 mm are not subjected to this test.

10.4.2 The test apparatus shall be placed on a pad of closed cell expanded sponge (40 ± 1) mm thick when uncompressed, and having a density of (538 ± 22) kg/m³. The test apparatus, together with the samples shall be placed in a refrigerator the temperature within which shall be maintained at the declared temperature specified in Table 1 with a tolerance of $\pm 2^\circ\text{C}$. When the samples have attained the temperature specified, or after 2 h, whichever is the longer period, each sample shall be placed in position on the steel base as shown in Figure 2. The hammer shall be allowed to fall, once on each sample. The mass of the hammer and the fall height shall be as specified in Table 8.

Table 8 – Impact Test Values

Classification	Conduit & Fittings	Mass of Hammer kg +1 - 0%	Fall Height mm +1 - 0%
1	Very light	0.5	100
2	Light	1.0	100
3	Medium	2.0	100
4	Heavy	2.0	300
5	Very heavy	6.8	300

The test shall be made on the weakest part of the conduit fitting except that it shall not be applied within 5 mm of any conduit entry. Samples of conduit are tested at the centre of their length.

10.4.3 After the test, at least in nine of the samples there shall be no sign of disintegration, nor shall there be any crack visible to normal or corrected vision without magnification and there shall be no deformation impairing its normal use.

10.5 Bending Test

10.5.1 Metallic conduits

10.5.1.1 Conduit sizes 16, 20 and 25 shall be subjected to a bending test by means of the apparatus shown in Figure 3. Testing of other sizes shall be in accordance with the manufacturer's instructions.

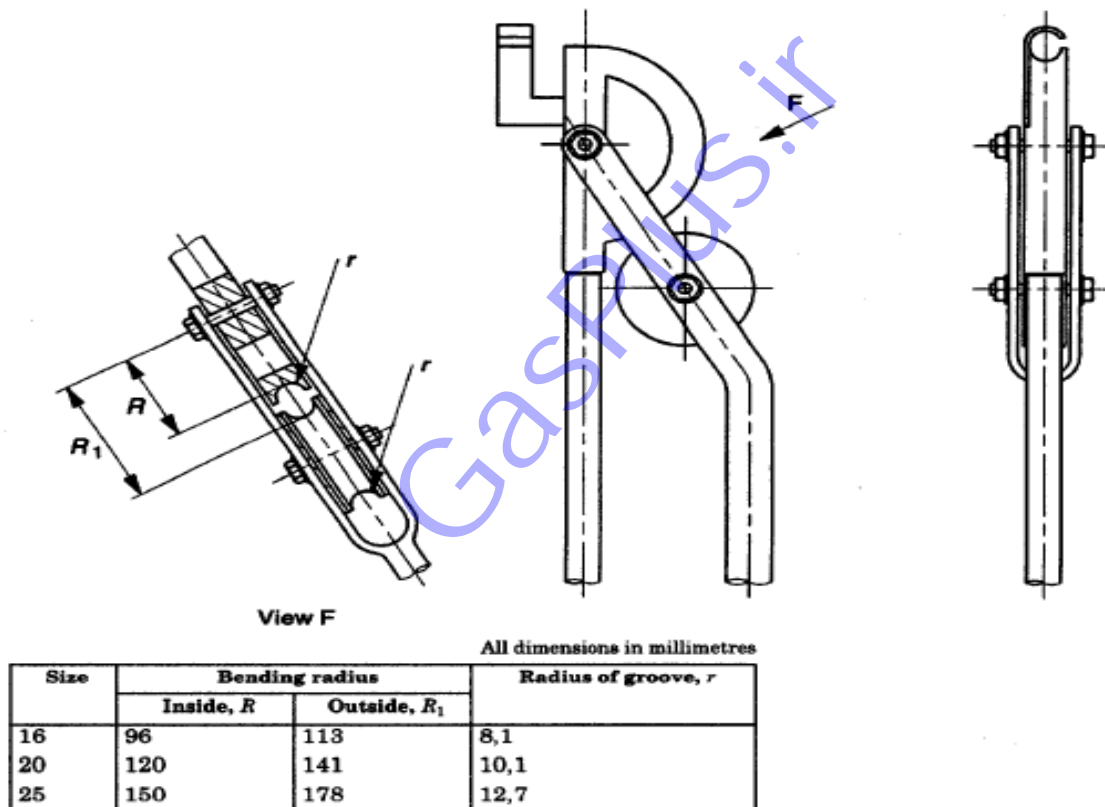


Figure 3 – Assembly of Conduit and Conduit Fittings for Bonding Test

10.5.1.2 Samples having a length equal to 30 times the outside diameter shall be bent through 90°, so that the inside radius of the bend is equal to six times the nominal diameter.

10.5.1.3 For conduits with welded seams, six samples shall be tested, three with the seam on the outside of the bend, three with the seam on the side.

10.5.1.4 After the test:

The basic material of the conduits and the protective coating of the conduits shall show no cracks visible to normal or corrected vision without magnification; seams, if any, shall not have opened; the section of the conduit shall not have distorted unduly. The distortion of the section shall be checked as follows. When the bent conduit is held in such a position that the straight portions are at 45° to the vertical, one end of the sample pointing upwards and the other downwards, it shall be possible to pass the appropriate gauge in accordance with Figure 4 through the sample under its own weight and without any initial speed.

10.5.2 Non-metallic conduits

10.5.2.1 Conduit sizes 16, 20 and 25 shall be subjected to a bending test by means of the apparatus shown in Figure 5. The length of the sample shall be approximately 500 mm. Testing of other sizes shall be in accordance with the manufacturer's instructions.

10.5.2.2 A bending aid, in the form of a coiled spring of square section metal wire, without burrs and having an overall diameter between 0,7 mm and 1,0 mm less than the specified minimum inside diameter of the conduit, or a bending aid recommended by the manufacturer, shall be inserted into each sample before bending.

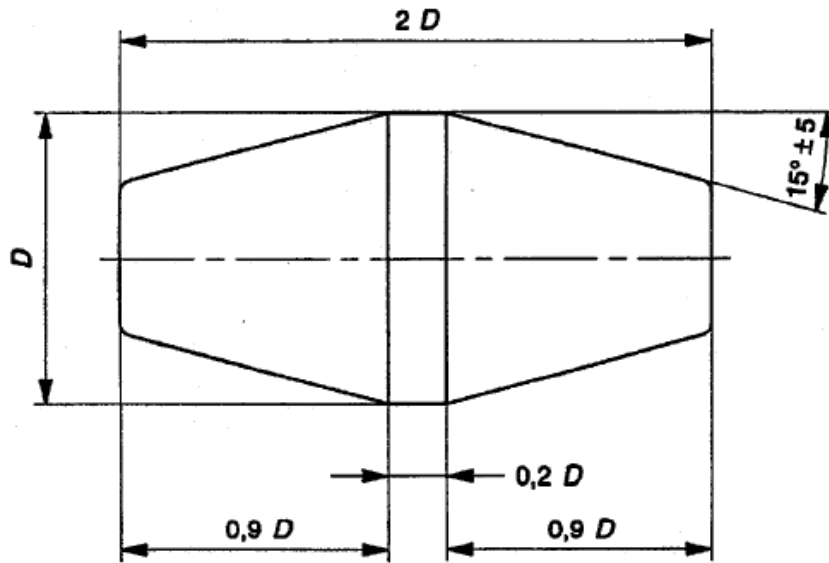
10.5.2.3 Before the test, the sample with the bending aid inserted shall be conditioned for at least 2 h in a refrigerator within which the temperature is maintained at the declared transport, permanent application and installation temperature in accordance with Table 1 with a tolerance of ± 2 °C. The bending apparatus shall be placed beside the refrigerator and the test shall be carried out within 10 s after the removal of the sample from the refrigerator.

10.5.2.4 Each sample shall be placed in position as shown in Figure 5, and held lightly in the groove of the former by means of the clamp. The sample shall be bent round the former by moving the bending rollers so that, when released, it has a bend of $(90^{+10}_0)^{\circ}$. In this position, it shall be possible to remove the bending aid without damage to the sample or the aid. After the test, the sample shall show no cracks visible to normal or corrected vision without magnification and it shall be possible to pass the appropriate gauge, in accordance with Figure 4, through the sample under its own weight and without any initial speed.

10.5.3 Composite conduits

Composite conduits which are declared by the manufacturer as being bendable shall be tested both in accordance with 10.4.1 and 10.4.2, using a new sample for each test.

The tests shall be carried out at the declared transport, permanent application and installation temperature in accordance with Table 1 with a tolerance of ± 2 °C.



$D = 80\%$ of the manufacturer's declared minimum inside diameter of conduit.

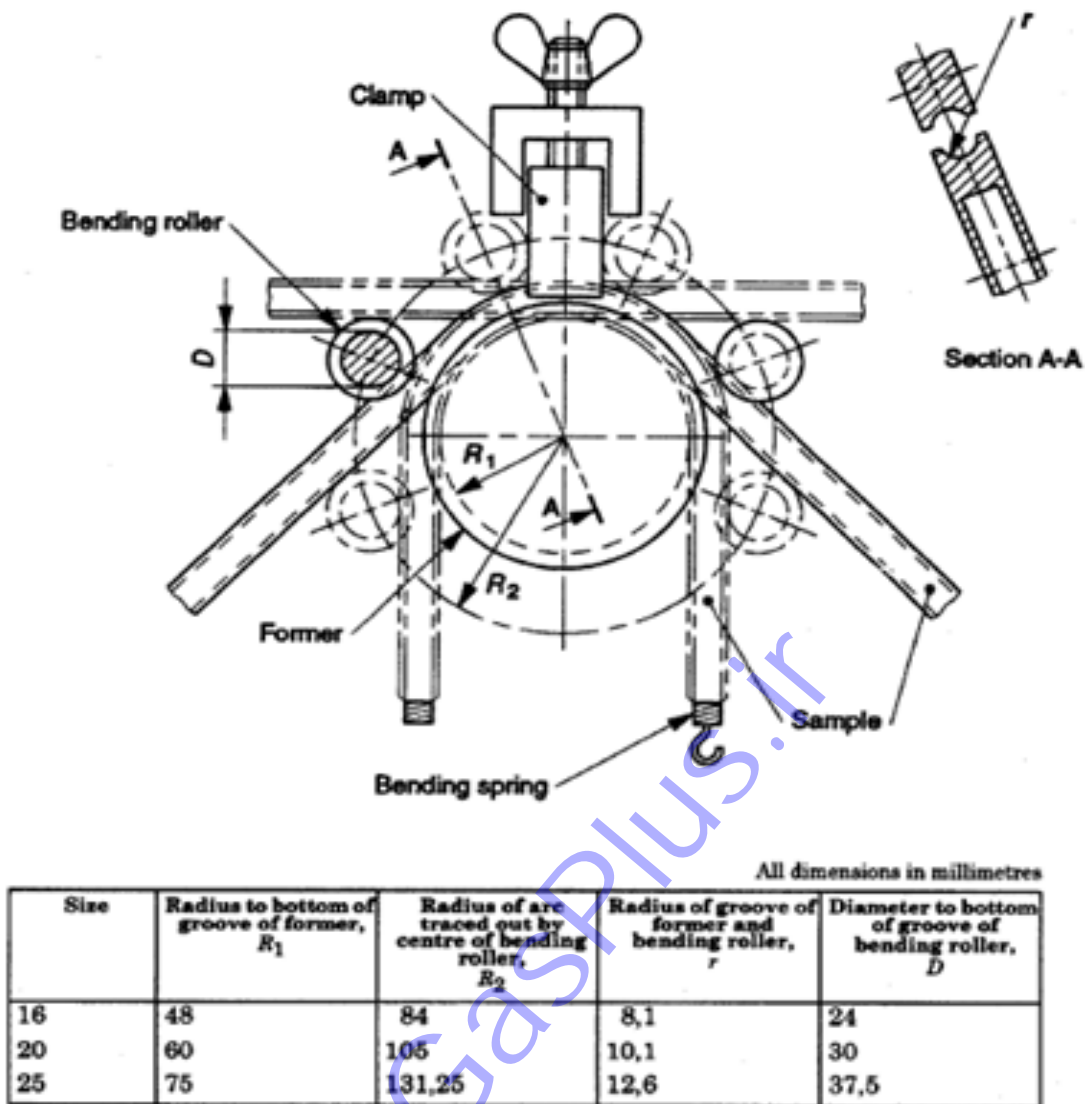
Material: Steel, hardened and polished, edges slightly rounded

Manufacturing tolerance: $+0,05$
 0 mm

Tolerance and axial dimension: $\pm 0,2$ mm

Admissible wear: 0,01 mm

Figure 4 – Arrangement for Insulation Resistance and Electric Strength Test Rigid Conduit



NOTE This drawing is not intended to govern design except as regards the dimensions shown.

Figure 5 – Arrangement for Insulation Resistance and Electric Strength Test Pliable and Flexible Conduit

10.6 Collapse Test

10.6.1 Metallic conduits

Metallic conduits shall not be subjected to a collapse test.

10.6. 2 Non-metallic and composite conduits

10.6.2.1 Conduits which are declared by the manufacturer as being bendable shall be tested in accordance with 10.4.102 with the exception of 10.4.102.3.

10.6.2.2 The samples shall be fixed to a rigid support by means of four straps as shown in Figure 6 after having removed the bending spring or any other bending aids recommended by the manufacturer.

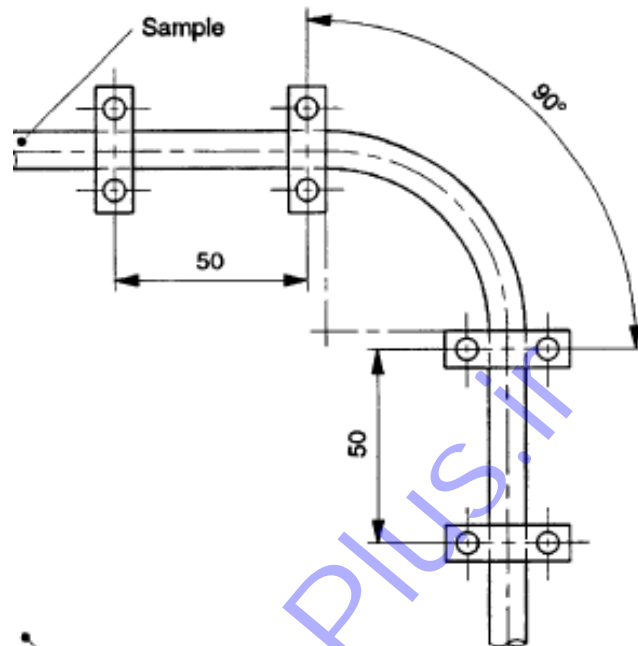


Figure 6 – Enclosure for Test for Resistance to Flame Propagation

The support with the sample in position shall be kept for $24 \text{ h} \pm 15 \text{ min}$ in a heating cabinet at the declared permanent application and installation temperature in accordance with Table 2 with a tolerance of $\pm 2 \text{ }^\circ\text{C}$. After this period, with the support in such a position that the straight portions of the sample are at 45° to the vertical, one end of the sample pointing upwards and the other downwards, it shall be possible to pass the appropriate gauge, in accordance with Figure 4, through the sample under its own weight and without any initial speed. (Annex A)

10.7 Tensile Test

10.7.1 Conduit systems declaring tensile strength shall be tested as follows:

A sample of conduit and two terminating fittings are assembled in accordance with the manufacturer's instructions so that the overall length is approximately 300 mm. The assembly is subjected to a slowly increasing tensile force over a period of 30 s to 40 s to the value specified in Table 9. After $2 \text{ min} \pm 10 \text{ s}$ the force is removed.

10.7.2 Where elongation occurs the manufacturer' shall be responsible for providing guidelines to assist the safe installation of the conduit system.

10.7.3 After the test, the terminating fittings shall remain properly assembled to the conduit and there shall be no damage visible to normal or corrected vision without magnification.

Table 9 – Tensile Force

Classification	Conduit & Fittings	Tensile Force [N] +2 - 0 %
1	Very light	100
2	Light	250
3	Medium	500
4	Heavy	1000
5	Very heavy	2500

10.8 Suspended Load Test

The conduit fitting declared by the manufacturer to be suitable for suspended loads, is secured to a rigid structure using a method provided by the manufacturer, with the suspension means pointing downwards. A load with time duration in accordance with Table 10 is suspended by the means provided and in accordance with the manufacturer's instructions. The fitting shall be deemed to have passed if at the end of the test, there are no cracks visible to normal or corrected vision without magnification, and there is no deformation of the conduit fitting impairing its normal use.

For non-metallic and composite conduit fittings the test shall be carried out in a heating cabinet, the temperature within which is maintained at the declared maximum temperature according to Table 2 with a tolerance of ± 2 °C.

Table 10 – Suspended Load

Classification	Conduit & Fittings	Load N + 2 – 0%	Duration hours + 15 -0 min
1	Very light	20,0	48
2	Light	30,0	48
3	Medium	150,0	48
4	Heavy	450,0	48
5	Very heavy	850,0	48

11. ELECTRICAL PROPERTIES

11.1 Conduit systems declaring electrical continuity characteristics shall be checked by the tests specified in 11.5 immediately after the tests specified in 14.2.(Annex A)

Note: conduit system may, in some circumstances be used in total or in part as a protective conductor in an electrical installation. In that event, the system will be tested after final installation to confirm its suitability for that purpose, in accordance with the installation rules.

11.2 Conduit systems of metal or composite materials shall be so constructed that accessible metal parts can be bonded to earth.

Compliance is checked by the test in 11.5.

11.3 Accessible conductive parts of the metal or composite conduit system, which may become live in the event of a fault shall be effectively earthed.

Compliance is checked by the test in 11.5.

11.4 Conduit systems of non-metallic or composite materials, where declared, shall have an adequate electrical insulating strength and insulating resistance. Compliance is checked by the test in 11.6.

11.5 Bonding Test

An arrangement of conduit and conduit fittings consisting of ten pieces of conduit shall be coupled together, in accordance with the manufacturer's instructions and Figure 7, by means of conduit fittings representing in approximately equal numbers, each type of fitting in the batch. The fittings shall be spaced between 25 mm and 28 mm apart. A current of 25A having a frequency of 50 Hz to 60 Hz derived from an a.c. source having a no-load voltage not exceeding 12 V, is passed through the assembly for 1 min (+5-0) s, after which the voltage drop is measured and the resistance calculated from the current and this voltage drop.

The resistance shall not exceed 0,05 Ω . If the numbers of different types of fittings cannot all be accommodated in a single test, the test described above shall be repeated until all such different types of fittings have been tested. Where special devices are required for the coupling of conduit and conduit fittings they shall be sufficient to remove the protective coating from the conduit, or the protective finish must be removed in accordance with the manufacturer's instructions.

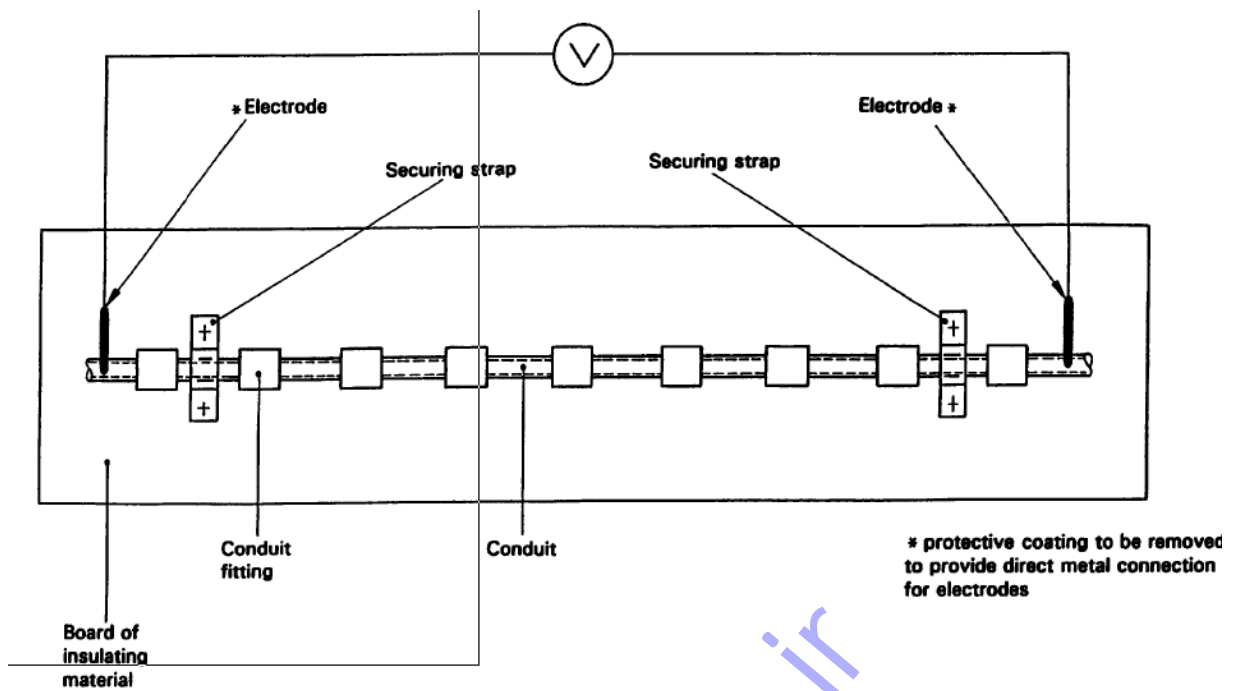


Figure7 – Assembly of Conduit and Conduit Fittings for Bonding Test

11.6 Electrical Insulating Strength and Resistance

11.6.1 Conduits

11.6.1.1 Samples of conduit are immersed over a length of $1\text{ m} \pm 10\text{ mm}$ in accordance with Figure 8 or Figure 9, in a salt, water solution at $(23 \pm 2)^\circ\text{C}$, with a length of 100 mm kept above the level of the solution. Rigid conduits samples are to be supplied by the manufacturer complete with one end sealed with an appropriate insulating material with high electrical insulation, e.g. silicon elastomer, see Figure 8. Pliable and flexible conduit samples are bent into a "U" shape and then immersed, see Figure 9. The salt water solution is made by completely dissolving 1 g/l of sodium chloride.

The salt water solution is poured into the open end of the conduit to match the external level. An electrode is placed inside the conduit and another placed into the tank.

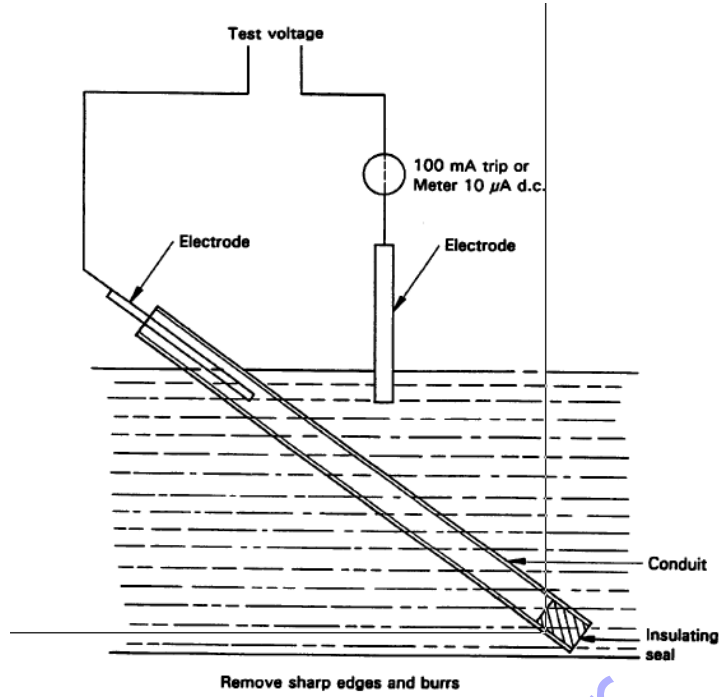


Figure 8 – Arrangement for Insulation Resistance and Electric Strength Test Rigid Conduit

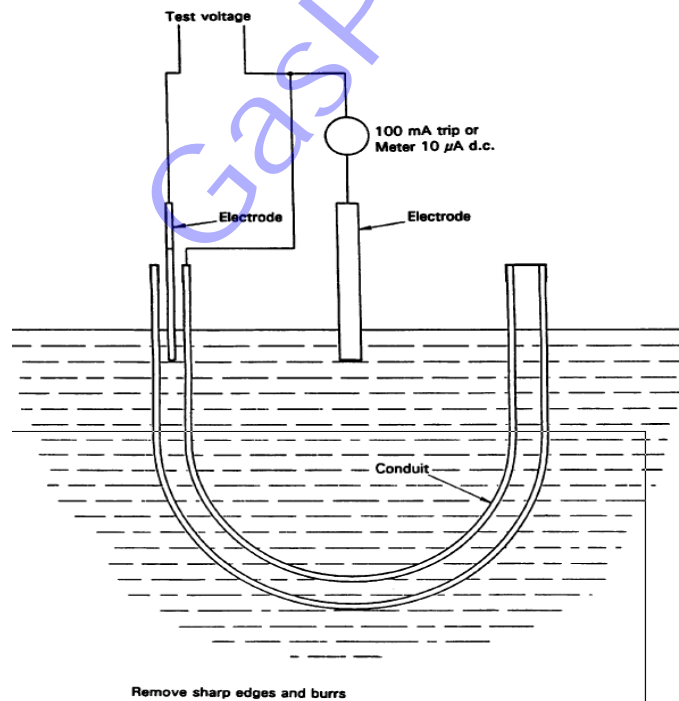


Figure 9 – Arrangement for Insulation Resistance and Electric Strength Test Pliable and Flexible Conduit

11.6.1.2 After $24 \text{ h} \pm 15 \text{ min}$, a voltage is applied across the two electrodes, gradually being increased from 1000 V to 2000 V of substantially sine wave form and having a frequency of 50 Hz to 60 Hz. Having reached 2000 V the voltage is maintained for a period of $15 \text{ min} + 5/0 \text{ s}$. The high-voltage transformer used for the test is so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is of at least 200 mA. The over current relay shall not trip when the output current is less than 100 mA. Care is taken that the R.M.S. value of the test voltage applied is measured within $\pm 3 \%$.

The samples shall be considered to have adequate electrical insulating strength if a 100 mA trip device, incorporated into the circuit does not trip during the 15 min test.

11.6.1.3 Immediately after the test in 11.6.1.2, the same samples shall be subjected to an electrical insulation resistance test. A direct voltage of 500 V shall be applied across the two electrodes.

11.6.1.4 After $(60 \pm 2) \text{ s}$, from the application of the voltage the insulation resistance between the electrodes shall be obtained. Conduits shall be considered to have adequate electrical insulation resistance if the measured resistance is greater than 100 M Ω .

11.6.2 Conduit fittings

11.6.2.1 Samples of conduit fittings shall be immersed for $24 \text{ h} \pm 15 \text{ min}$, in water at $(23 \pm 2) \text{ }^\circ\text{C}$ and then thoroughly dried at room temperature.

11.6.2.2 Conduit fitting samples shall be assembled in accordance with the manufacturer's instructions with a short length of conduit. All other open ends are sealed with an appropriate insulating material. The inside of the fitting is filled with lead shot of a diameter between 0, 5 mm and 1, 0 mm, and an electrode is inserted into the lead shot via the conduit.

An outer electrode of aluminum foil with a thickness of $(0, 08 \pm 0, 02) \text{ mm}$, is wrapped around the outside of the fitting and compressed so that it follows the outer contour of the fitting as closely as possible.

11.6.2.3 Conduit fitting samples shall be tested in accordance with 11.6.1.2 within one hour of removal from the water.

11.6.2.4 Immediately after the test in 11.6.2.3, the same samples are subjected to an electrical insulation resistance test. A d.c. voltage of 500V is applied across the two electrodes.

11.6.2.5 After $(60 \pm 2) \text{ s}$, from the application of the voltage the insulation resistance between the electrodes is obtained. Fittings are considered to have adequate electrical insulation resistance if the resistance is greater than 5 M Ω .

12. THERMAL PROPERTIES

12.1 Resistance to Flame Propagation

12.1.1 Non-flame propagating conduit systems shall have adequate resistance to flame propagation.

12.1.2 Samples of non-metallic and composite conduit shall be checked by applying a 1kW flame, specified in EN 60695-2-4/1 in accordance with 12.1.2.1, 12.1.2.2, 12.1.2.3 and 12.1.2.4.

12.1.2.1 A sample of length (675 ± 10) mm is mounted vertically in a rectangular metal enclosure with one open face, as shown in Figure 10 in an area substantially free from draughts. The general arrangement is shown in Figure 11. Mounting is by means of two metal clamps approximately 25 mm wide spaced (550 ± 10) mm apart and approximately equidistant from the ends of the sample.

A steel rod of $(2,0 \pm 0,1)$ mm for sizes up to 12 mm, $(6,0 \pm 0,1)$ mm for sizes 16 to 25 mm and $(16,0 \pm 0,1)$ mm for conduits with diameters 32mm and above, is passed through the sample. It is rigidly and independently mounted and clamped at upper end to maintain the sample in a straight and vertical position. The means of mounting is such as not to obstruct drops from falling onto the tissue paper. A suitable piece of white pinewood board, approximately 10 mm thick, covered with a single layer of white tissue paper, is positioned on the lower surface of the enclosure. The assembly of sample, rod and clamping apparatus is mounted vertically in the centre of the enclosure, the upper extremity of the lower clamp being (500 ± 10) mm above the internal lower surface of the enclosure.

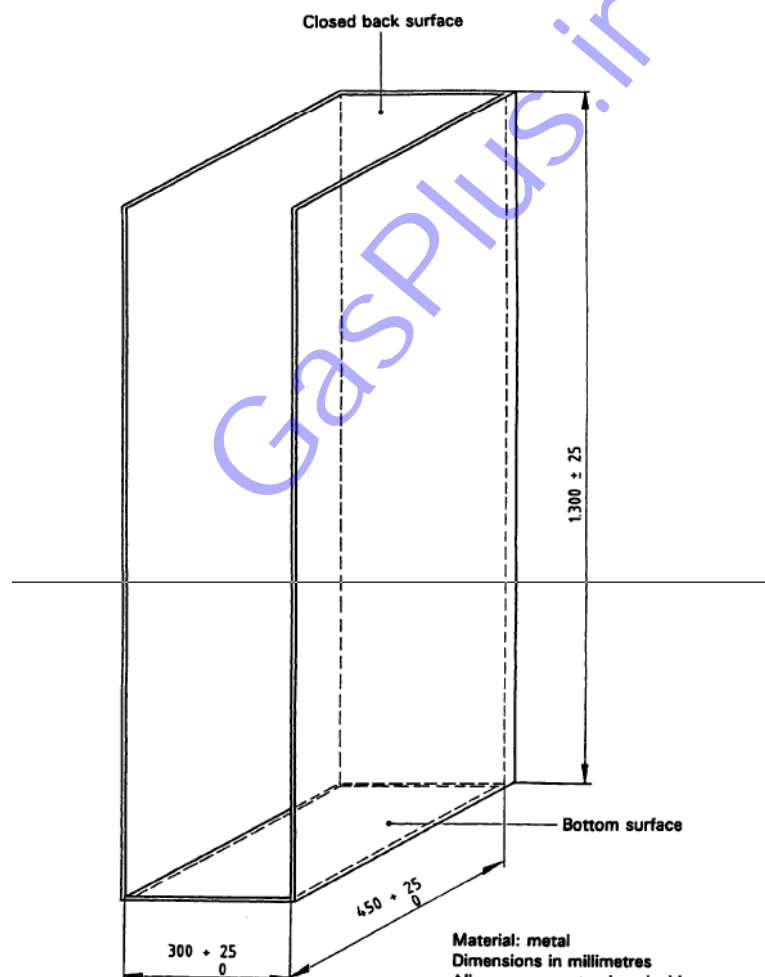


Figure 10 – Enclosure for Test for Resistance to Flame Propagation

Table 11 – Times Exposure of Sample to the Flame

Material Thickness mm		Flame Application Time $S + 1 - 0_s$
Over	Up to	
---	0.5	15
0.5	1.0	20
1.0	1.5	25
1.5	2.0	35
2.0	2.5	45
2.5	3.0	55
3.0	3.5	65
3.5	4.0	75
4.0	4.5	85
4.5	5.0	130
5.0	5.5	200
5.5	6.0	300
6.0	6.5	500

12.1.2.4 All three samples shall pass the test. If the sample is not ignited by the test flame it shall be deemed to have passed the test. If the sample burns, or is consumed without burning, the sample shall be deemed to have passed the test if after any burning has ceased, and after the sample has been wiped in accordance with

12.1.2.5 There is no evidence of burning or charring within 50 mm of the lower extremity of the upper clamp and also within 50 mm of the upper extremity of the lower clamp. If the sample burns, it shall be deemed to have failed the test if combustion is still in progress 30 s after removal of the flame. If the tissue paper ignites, the sample shall be deemed to have failed the test. For the part of the sample below the burner, the presence of molten material on the internal or external surfaces shall not entail failure if the sample itself is not burned or charred.

12.1.3 Compliance of non-metallic and composite conduit fittings is checked by using the glow wire test in IEC 60695-2-1. The glow wire shall be applied once to each sample in the most unfavorable position of its intended use, (with the surface tested in a vertical position), at a temperature of 750 °C. The samples deemed to have passed this test if there is no visible flame or sustained glowing, or if flames or glowing extinguishes within 30 s, of the removal of the glow wire.

12.2 Resistance to Heat

12.2.1 Non-metallic and composite conduits shall have adequate resistance to heat. Compliance is checked by the test given in 12.2.3.

12.2.2 The load for the heating test shall be the same classification as the declared compression classification.

12.2.3 Samples of conduit , each (100 ± 5) mm long together with the test apparatus as shown in Figure 12 shall be kept for $4 \text{ h} \pm 5 \text{ min}$, in a heating cabinet at the declared temperature given in Table 2 with a tolerance of $\pm 2 \text{ }^\circ\text{C}$.

After this period each sample is loaded for $24 \text{ h} \pm 15 \text{ min}$, in an apparatus, as shown in Figure 12 , with an appropriate mass applied through a steel rod, $(6,0 \pm 0,1)$ mm in diameter, disposed at right angles to the axis of the conduit.

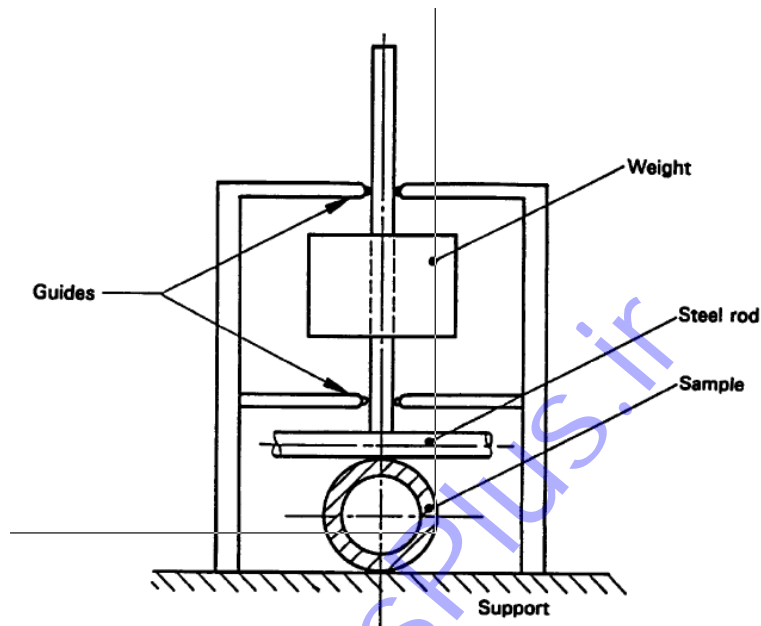


Figure 12 – Test Apparatus for Resistance to Heat

The sample is subjected to a total mass, including the mass of the rod, as shown in Figure 12 , placed in the middle of the sample. The sample, under load, shall then be allowed to cool to room temperature.

Table 12 – Load for Heating Test

Classification	Conduits	Mass kg +4 - 0
1	Very light	0.5
2	Light	1.0
3	Medium	2.0
4	Heavy	4.0
5	Very heavy	8.0

12.2.4 The load is then removed and immediately after its removal it shall be possible to pass the appropriate gauge, specified in the relevant this standard through the conduit, under its own weight and without any initial speed, with the sample in the vertical position

12.2.5 Replacement

The load is then removed and immediately after its removal it shall be possible to pass the appropriate gauge, in accordance with Figure 4, through the conduit under its own weight and without any initial speed, with the sample in the vertical position.

13. FIRE EFFECTS

Under consideration.

14 EXTERNAL INFLUENCES

14.1 Degree of Protection Provided by Enclosure

Conduit systems when assembled in accordance with the manufacturer's instructions shall have adequate resistance to external influences according to the classification declared by the manufacturer with a minimum requirement of IP30.

Compliance and 14.1.2, is checked by the tests specified in 14.1.1

14.1.1 Degree of protection – Ingress of foreign solid objects

14.1.1.1 An assembly is made of a conduit fitting with a short length of conduit assembled in each entry. Where necessary, the open ends of the assembly are plugged, or are not part of the test.

14.1.1.2 The assembly shall be tested in accordance with the appropriate test of EN 60529 except as follows.

14.1.1.3 The assembly shall be tested in accordance with the appropriate test of EN 60529

14.1.1.4 Addition

When tested for first numeral 5 or 6, the assembly shall be tested as a category 2 enclosure.

14.1.1.5 The assembly tested for numeral 5 or 6 shall be deemed to have passed the test if here is no ingress of dust visible to normal or corrected vision without magnification.

14.1.2 Degree of protection – Ingress of water

14.1.2.1 An assembly is made of a conduit fitting with a short length of conduit assembled in each conduit entry. Where necessary, the open end of the conduit is plugged, or is not part of the test. When tested for second numeral 3 or 4, the assembly shall be tested using the oscillating tube.

14.1.2.2 The assembly shall be tested in accordance with the appropriate test of EN 60529.

14.1.2.3 The assembly tested for numeral 1 and above shall be deemed to have passed the test if there is not sufficient ingress of water to forma drop visible to normal or corrected vision without magnification.

14.2 Resistance Against Corrosion

14.2.1 Metallic and composite conduit systems, excluding screw threads, shall have adequate resistance against corrosion, both inside and outside, in accordance with the classification shown in Table 13. Compliance is checked by the tests specified in 13.2.2.1, 13.2.2.2 and 13.4.2.3.

14.2.2 Tests for resistance to corrosion for steel and steel composite conduit systems.

Table 13 – Resistance to Corrosion Classification

Classification	Protection afforded	Example
1	Low protection, inside & out side	Priming paint
2	Medium protection, inside & out side	Stove enamel/electro zinc plate/air drying paint
3	Medium/High composite protection Inside , Class2 outside , Class4	Stove enamel Sheradizing
4	High protection, inside, & out side	Hot dip zing coating Sheradizing Stainless steel

14.2.2.1 Low Protection

Conduit and conduit fittings shall be inspected for completeness of covering by the protective coating, both inside and outside.

14.2.2.2 Medium Protection

Conduit and conduit fittings shall be cleaned with a piece of wadding soaked in trichloroethane or similar agent and then dried.

They shall then be totally immersed in a solution of 0,75 %potassium ferricyanide [$K_3Fe(CN_6)$] and 0,25 % ammonium persulfate [$(NH_4)_2 S_2 O_8$] in water and a quantity of about 0,1 % of a suitable wetting agent, for instance a sodium salt of an alkylnaphthaline sulfuric acid, shall be added. The solution and the samples shall be maintained at a temperature of $(23 \pm 2) ^\circ C$. Each

sample shall be tested separately, a fresh solution being used each time. After immersion for 5 min + 5/0 s, and the samples shall be removed from the solution and left to dry at ambient temperature in air. After completion of the test as described above, the samples shall show no more than two blue colored spots on each square centimeter of the surface, and no blue spot shall have a dimension larger than 1,5 min. Traces of rust on sharp edges, screw threads and machined surfaces, also any yellowish film removable by rubbing, shall be ignored.

14.2.2.3 High protection

Conduit and conduit fittings shall be degreased by immersion in trichloroethane or a similar degreasing agent for 10 min + 5/0 s, and wiped dry with a piece of soft cloth. They shall then be immersed in a 2% solution of sulfuric acid in water for 15 s, thoroughly cleaned in running water and again wiped dry with a piece of clean soft cloth.

Each sample shall then be totally immersed in a solution of copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in distilled water, having a specific gravity of $1,186$ at $(23 \pm 2)^\circ\text{C}$. The solution and the samples shall be maintained at a temperature of $(23 \pm 2)^\circ\text{C}$, without stirring.

Note: The solution is made by dissolving 360 g of crystalline copper sulfate in one liter of distilled water and neutralizing with copper carbonate or copper hydroxide (about 1 g/l). The specific gravity is then checked and adjusted as necessary.

The container shall be such that it will not react with the solution and shall be of such a size as to provide clearance of at least 25 mm, between the walls thereof and the sample.

Each sample shall be immersed four times in succession in the same solution, each time for $(60 + 5/0)$ s. A fresh solution shall be used for each sample. After each immersion the sample shall immediately be cleaned in running water with a brush to remove any black deposit. The sample shall then be wiped dry with a piece of clean soft cloth, and, except after the fourth immersion, returned to the solution. Care should be taken to clean out all holes and pockets.

After the test the sample shall show no precipitation of copper which cannot be scrubbed off in running water, if necessary after immersion for 15 s in a 10 % solution of hydrochloric acid in water. Traces of copper precipitation on screw threads, sharp edges and machined surfaces may be ignored.

14.2.3 Tests for resistance to corrosion for metals other than steel – under consideration.

15. ELECTROMAGNETIC COMPATIBILITY

Products covered by this standard are, in normal use, passive in respect of electromagnetic influences (emission and immunity).

Note: When products covered by this standard are installed as part of a wiring installation, the installation may emit or may be influenced by electromagnetic signals. The degree of influence will depend on the nature of the installation within its operating environment and the apparatus connected by the wiring.

**ANNEX A
Classification Coding for Conduit Systems
(normative)**

Note: Annex A shows the classification coding format for declared properties of the conduit system, which may be incorporated in the manufacturer's literature.

First Digit – Resistance to Compression	
Very light compression strength	1
Light compression strength	2
Medium compression strength	3
Heavy compression strength	4
Very heavy compression strength	5

Second Digit – Resistance to Impact	
Very light compression strength	1
Light compression strength	2
Medium compression strength	3
Heavy compression strength	4
Very heavy compression strength	5

Third Digit – Minimum Permanent Application & Installation Temperature	
+ 5 °C	1
- 5 °C	2
-15 °C	3
-25 °C	4
-45 °C	5

Fourth Digit – Maximum Permanent Application & Installation Temperature	
+60 °C	1
+90 °C	2
+105 °C	3
+120 °C	4
+150 °C	5
+250 °C	6
+400 °C	7

Fifth Digit – Resistance to Bending	
Rigid	1
Pliable	2
Pliable/Self-recovering	3
flexible	4

Sixth digit—Electrical properties	
None declared	0
With electrical continuity characteristics	1
With electrical insulating characteristics	2
With electrical continuity & insulating characteristics	3

Seventh Digit – Resistance to Ingress of Solid Object	
Protected against solid foreign objects of 2.5mm dia. and greater	3
Protected against solid foreign objects of 1.0 mm dia. and greater	4
Dust protected	5
Dust-tight	6

Tenth Digit – Tensile Strength	
None declared	0
Very light tensile strength	1
Light tensile strength	2
Medium tensile strength	3
Heavy tensile strength	4
Very heavy tensile strength	5

Eight Digit – Resistance to Ingress of Water	
None declared	0
Protected against vertically falling water drops	1
Protected against vertically falling water drops when conduit system tilt up to 15	2
Protected against spraying water	3
Protected against splashing water	4
Protected against water jets	5
Protected against powerful water jets	6
Protected against the effects of temporary in water	7

Eleventh Digit – Resistance to Flame Propagation	
None flame propagating	1
Flame propagating	2

Ninth Digit – Compression Resistance of Metallic & Composite Conduit Systems	
Low protection inside & outside	1
Medium protection inside protection outside	2
Medium protection inside high protection outside	3
High protection inside & outside	4

Twelfth Digit – Suspended Load Capacity	
None declared	0
Very light suspended load capacity	1
Light suspended load capacity	2
Medium suspended load capacity	3
Heavy suspended load capacity	4
Very heavy suspended load capacity	5

Thirteenth Digit – Fire Effect under Consideration