



IRANIAN PETROLEUM STANDARD

IPS

**MATERIAL AND EQUIPMENT STANDARD
FOR
MEDIUM AND HIGH VOLTAGE
POWER CABLES**

**FIRST REVISION
JULY 2003**

FOREWORD

This Standard is intended to be used within and for Iranian Ministry of Petroleum (N.I.O.C, N.I.G.C, N.P.C., N.I.O.R.D.C. and other affiliate organizations and companies) and has been prepared on the basis of the recognized standards, scientific publications, technical documents, accumulated knowledge and experiences in petroleum industries at national and international levels.

Iranian Petroleum Standards are prepared by Iranian Petroleum Standards Organization reviewed and amended by the relevant technical standard committees to incorporate acceptable comments made by oil, gas and petrochemical experts.

Standards are finally approved by the “Standards High Council” of Iranian Ministry of Petroleum.

Iranian Petroleum Standards (IPS) are subject to amendment withdrawal, if required, thus the latest edition of IPS shall be applicable.

Any comment or recommendation submitted to the “Iranian Petroleum Standards Organization” will be evaluated in the relevant technical committee and will be considered in the next revision, upon approval.

GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

“**COMPANY**” : Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company etc.

“**PURCHASER**” : Means the “Company “ Where this standard is part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

“**VENDOR**” and “**SUPPLIER**” : Refers to firm or person who will supply and/or fabricate the equipment or material.

“**WILL**” : Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

“**MAY**” : Is used where a provision is completely discretionary.

“**SHOULD**” : Is used where a provision is advisory only.

“**SHALL**” : Is used where a provision is mandatory.

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1. SCOPE

1.1 This Standard specification covers the minimum requirements for the materials, manufacture, inspection and testing of medium voltage and high voltage power cables from 6 kV up to 30 kV to be used in oil, gas and petrochemical industries in Iran under the service conditions stated herein.

1.2 The general requirements of cables are given in this specification. The specific requirements of individual cases will be given in request for quotation and / or purchase order.

Note: The standard specification for cables and wires IPS-M-EL-270(0) is withdrawn, and replaced by the following three standard specifications which are issued as Revision (1).

- [IPS-M-EL-271\(1\)](#) : Low voltage cables and wires
- [IPS-M-EL-272\(1\)](#) : Medium and high voltage power cables
- [IPS-M-EL-273\(1\)](#) : Submarine power cables with inherent optical fibers

2. REFERENCES

2.1 Cables shall be designed, manufactured, inspected and tested in accordance with applicable sections of the latest edition of international electrotechnical commission "IEC" standards, including the following:

IEC 60038	Standard voltages
IEC 60183	Guide to the selection of high voltage cables
IEC 60228	Conductors of insulated cables
IEC 60287	Electric cables-calculation of current rating
IEC 60332	Test on electric cables under fire conditions
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 6 kV up to 30 kV
IEC 60502-4	Test requirements on accessories for cables 6 kV up to 30 kV
IEC 60811	Common test methods for insulating and sheathing materials of electric cables

2.2 Where standards other than IEC are specified, it is understood that the equivalent IEC standard is acceptable.

2.3 Any deviation from this specification and the above mentioned references shall be clearly mentioned in the vendor's proposal.

3. SERVICE CONDITIONS

3.1 The cable under this specification will be either buried directly in sand filled underground trenches or will be installed on trays.

3.2 The method of installation and the environmental conditions will be indicated in data sheet appendix A.

4. VOLTAGE DESIGNATIONS

4.1 The voltage levels adopted in the oil, gas and petrochemical industries of Iran are based on the IEC recommendation No. 60038.

4.2 Power cables are designated for the rated voltages U_0/U for which the cables are designed. U_0 is the voltage between conductor and earth and U is the voltage between conductors.

4.3 The cables designated 0.6/1 kV rms are called low voltage (LV) cables, the cables designated 3.6/6 kV rms are called medium voltage (MV) cables, and the cables designated 6/10 kV, 12/20 kV and 18/30 kv are called high voltage (HV) cables.

4.4 The available medium voltage power in the Iranian Petroleum industry is 3.6/6 kV.

4.5 The available high voltage power in the Iranian petroleum industry is 6/10 kV and 12/20 kV. For special cases upon the approval of company representative 18/30 kV could be adopted.

4.6 The highest system voltages according to IEC recommendations is 7.2 kV for 6 kV systems, 12 kV for 10 kV systems, 24 kV for 20 kV systems and 36 kV for 30 kV systems.

4.7 Unless otherwise indicated in data sheet Appendix A, the neutral point of medium voltage and high voltage systems are earthed through current limiting resistors.

5. CABLES CROSS SECTION

5.1 The conductors cross section of cables will be determined according to relevant IPS publication and will be indicated in data sheet Appendix A.

5.2 Unless otherwise approved by the company representative, the maximum conductor cross section of the medium voltage and high voltage power cables shall be limited to 240 mm² for three core cables and 400 mm² for single core cables.

5.3 When this specification is used as a part of an EPC contract, the contractor shall calculate the cross section of the conductors, taking into account the guidelines outlined in the relevant IPS including the following factors.

- Ambient temperature
- Method of installation
- Thermal resistivity of the soil for buried cables
- Maximum sunlight temperature for cables in trays
- Grouping factor
- Allowable voltage drop
- System short circuit current
- Current carrying capacity of cables according to manufacturer recommendation and IEC publication 60287

6. INSULATION COLOR AND CABLE MARKING

6.1 The conductors' insulation color of 3 core medium and high voltage power cables shall be red, yellow and blue. In special cases, other colors can be specified by the company representative, which will be indicated in data sheet, appendix A.

6.2 Colors shall be indelible. If colored material for insulation will not be available, each core shall be wrapped with tapes of appropriate color. The tapes shall be PVC or equivalent and shall cover 100% of the surface of each core.

6.3 The insulation color of earthing cables shall be PVC with green/yellow color.

6.4 The color of the outer sheath of all medium voltage and high voltage power cables shall be red. At least the following information shall be printed on the outer sheath of the cables, at reasonable intervals according to manufacturer standard.

- Manufacturer's name
- Year of manufacture
- Type of insulation
- Rated voltage
- Number of cores
- Size of conductors
- Other information requested in purchase order.

6.5 Cable identification tags showing the cable identification number as appears in data sheet/s will be fixed on the cables (by installer). Tags shall be stainless steel or equivalent and shall be fixed on the whole length of each cable at intervals of every 20 meters, and also on bends and crossings.

7. CABLE ACCESSORIES

7.1 Where indicated in data sheet, cable accessories such as cable glands, termination kits, straight joints, branch joints, stop-ends, insulating tapes, sealing compounds etc. together with any special tools or testing equipment shall be provided by the cable supplier. Such items shall be quoted separately. The accessories for MV and HV cables shall fulfill the test requirements of IEC 60502-4.

8. MEDIUM AND HIGH VOLTAGE CABLES CONSTRUCTION

8.1 Medium and high voltage cables shall be copper conductor with Cross Linked Polyethylene (XLPE) insulation, lead sheathed, single wire armoured and PVC overall jacket. The cross section of conductors will be indicated in data sheet. The lead sheath may be replaced by other metallic sheath/s which shall be approved by company representative.

8.2 Conductors

Conductors shall be circular plain annealed stranded copper conforming to class 2 of IEC 60 228.

8.3 Conductor Screen

The conductor screen shall be non-metallic and shall consist of extruded semi-conducting compound, which may be applied on top of a semi-conducting tape. The extruded semi-conducting compound shall be firmly bonded to the insulation.

8.4 Insulation

The insulation of medium voltage and high voltage cables shall be extruded Cross Linked Polyethylene (XLPE). The minimum thickness of the insulation shall be according to table 6 of IEC 60502-2.

8.5 Insulation Screen

The insulation screen shall consist of a non-metallic semi-conducting layer in combination with a metallic layer.

The non-metallic layer shall be extruded directly upon the insulation of each core and shall consist of either a bonded or strippable semi-conducting compound.

The metallic layer shall consist of a tape, or a braid, or a concentric layer of wires, conforming to the recommendations of IEC 60502-2.

The metallic layer shall be copper or other non magnetic metal of manufacturer standard, with a thickness of not less than 75 um and shall be applied with 15% overlap over the non-metallic layer.

8.6 Filler

Cores shall be laid up together such that the metallic layers of the insulation screen of the cores are in contact with each other.

The interstices between the cores shall be filled with suitable material compatible with the XLPE insulation and operating temperature of the cables.

8.7 Binder

The laid up cores, together with fillers shall be lapped with suitable binder tapes/s. The tape/s shall be non-hygroscopic.

8.8 Metallic sheath

The metallic sheath shall consist of lead or lead alloy and shall be applied as a reasonably tight-fitting seamless tube. The nominal thickness of the lead sheath shall be calculated by the formulas recommended in IEC 60502-2 and shall in no case be less than 1.2 mm. If approved by company representative, for cables which will be installed on trays or will be buried in places where the presence of hydrocarbon is not foreseen lead sheath may be replaced by other metallic sheath/s. In such cases the metallic sheath/s may consist of one or two layer/s of bronze tape/s or equivalent metallic tape/s of manufacturer standard. The total thickness of such metallic sheath shall not be less than the calculated thickness for lead sheath according to the recommended formulas of IEC 60502-2.

8.9 Bedding

The bedding under the armour shall be extruded or lapped layer/s of PVC or synthetic tape/s of manufacturer standard. The thickness of the bedding shall be according to the recommendations of IEC 60502-2 and shall not be less than 1.5 mm.

8.10 Armour

The armour shall be galvanized round steel wire supplemented by a helix of galvanized steel tape to keep the armour wires tight. At the discretion of the company representative, such galvanized steel tape may be eliminated. Flat wire armour is not desirable, however it could be considered upon the approval of company representative. The minimum dimensions of the armour wires shall be in accordance with the requirements of IEC 60502-2. The thickness of the galvanized steel tape shall be 0.3 mm. For single core cables the armour shall be made of non-magnetic materials.

8.11 Over Sheath

The outer sheath over the armour shall be extruded red PVC complying with the requirements of IEC 60502-2. To protect the cables against rodent and termite attack, suitable chemicals shall be added to PVC over sheath.

For cables to be installed on trays, as indicated in data sheet, the over sheath shall be made of flame retardant PVC or an elastomeric compound which satisfies the requirements of the latest edition of IEC publication series No 60332.

9. CABLE TESTS AND INSPECTION

9.1 Routine tests, sample tests and type tests shall be carried out at manufacturer work according to the recommendations of IEC 60502-2, and the relevant publications referred to therein.

9.2 Type tests, electrical and non-electrical, shall be performed on samples from each type of cables.

9.3 Test certificates shall be submitted to purchaser in three copies.

9.4 The purchaser may appoint representative/s or third party to witness the factory tests on cables. The supplier shall inform the date of performing such tests, at least four weeks in advance.

9.5 The purchaser's inspectors shall be granted the right for inspection at any stage of manufacture, testing and preparation for shipment.

10. PACKING FOR SHIPMENT

10.1 The cables shall be supplied on non returnable drums with steel reinforced hub plates, the inner end of cables shall be brought out through the side of the drum/s.

10.2 Each drum shall be durably marked on the outside of the flange, with particulars of the cable i.e. voltage, length, conductor size, and cable type. The gross mass shall be shown and the direction of rolling shall be indicated by arrow.

10.3 Cable drums shall be provided with a permanently attached readily visible identification tags. Identification tags should remain intact from the time of initial dispatch at work to the final destination.

10.4 Before dispatch the manufacturer shall seal and cap both ends of cables so that to prevent the ingress of water during transportation and storage, projecting end of cables shall be protected from mechanical damage.

10.5 The cable/s manufacturer shall be the sole responsible for adequacy of preparation for shipment of cables.

10.6 Shipping documents with exact description for custom release shall be included.

11. GUARANTEE

11.1 All cables shall be guaranteed against defective material, poor design and workmanship.

11.2 The vendor shall guarantee the cables performance under specified conditions.

11.3 If any defect is discovered during the d.c. voltage test performed after the cable installation, the vendor shall be responsible for replacement of the cable free of charge.

Unless otherwise agreed between the cable vendor and the purchaser, the d.c. test voltage shall be equal to 4 U_o and shall be applied for fifteen minutes according to the recommendations of IEC 60502-2.

APPENDIX A

MEDIUM AND HIGH VOLTAGE CABLE DATA SHEET

The vender shall complete and submit this data sheet with his proposal.

1.	Name of projector or plant	*
2.	Cable identification number	*
3.	Operating voltage phase to phase (kV)	*
4.	Cable insulation voltage 3.6/6kV, 6/10kV, 12/20Kv, 18/30kV	*
5.	System frequency (50 Hz)	*
6.	System grounding	*
7.	Method of installation (buried or on trays)	*
8.	Maximum ambient temperature	*
9.	Maximum sunlight temperature	*
10.	Thermal resistivity of soil	*
11.	Numbers of cores (separate list can be attached)	*
12.	Size of conductors (mm ²) (separate list can be attached)	*
13.	Lengths(m) (separate list can be attached)	*
14.	Type of copper conductors; stranded, solid/round, shaped	
15.	Conductor screen	
16.	Insulation	
17.	Insulation screen, non metallic layer	
18.	Insulation screen, metallic layer	
19.	Type of filler	
20.	Material of binder	
21.	Material and thickness of metallic sheath	
22.	Bedding	
23.	Type of armour, flat or round wire armour	
24.	Wire armour diameter (mm)	
25.	Thickness of the galvanized steel tape (mm)	
26.	Type and thickness of over sheath	
27.	Color of cores	
28.	Color of over sheath	
29.	Current rating in air at ISO condition	
30.	Current rating in ground	
31.	DC resistance at 20°C ohm/km	
32.	AC resistance at 20°C ohm/km	
33.	Inductance milli H/km	
34.	Capacitance core to core micro F/km	
35.	Capacitance core to earth micro F/km	
36.	Voltage drop per ampere per km	
37.	Fault current capacity for one second and 0.5 second	
38.	Diameter under armour (mm)	
39.	Over all diameter (mm)	
40.	Minimum recommended bending radius of the cable (m)	
41.	Maximum tensile strength of the cable	
42.	Weight (kg/m) or kg per 100 meter	
43.	Maximum cable length on each cable drum	
44.	Cable accessories	See Attached list

* by purchaser

Note to Users

The IPS Standards reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS publications are based on internationally acceptable standards and include selections from the options stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement or diversity of conditions of each project or work.

For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The users of IPS publications are therefore requested to send their views and comments, including any addendum prepared for particular cases to the Ministry of Petroleum, Standards and Research Organization. These comments and recommendations will be reviewed by the relevant technical committee and will be incorporated in the formal revision of the relevant IPS. The IPS publications are reviewed and revised approximately every five years.

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