



**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION BUSINESS GROUP**  
**TRANSMISSION BUSINESS ENGINEERING MANAGEMENT**  
**NEW DELHI**

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TITLE <b>TECHNICAL SPECIFICATION FOR 420 kV XLPE CABLE</b>		SIGN	-SD-	-SD-	-SD-
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		GROUP	TBEM	W.O. No	
CUSTOMER/ CONSULTANT	<b>Pragati Power Corporation Limited NTPC Limited , Consultancy Wing</b>				
PROJECT	<b>750 MW Pragati CCPP at Bamnauli</b>				

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**CONTENTS**

Sec. No.	Description	No. of Sheets
1.	Scope Specific Technical Requirement and Quantities	6
	Annexue-1 & 2	2
2.	Equipment Specification	9
3.	Guaranteed Technical Particulars	5

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## **SECTION 1**

### **SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES**

#### **1.0 SCOPE:**

This technical specification covers the requirements of design, manufacturing, testing at works, packing and dispatch, transporting, laying of cable at site in BHEL provided trenches, testing and commissioning at site of 400kV XLPE Cables , Termination etc complete in all respect along with accessories .

The scope involves diversion of total 4 nos 400 kV lines : 400 kV Bawana - Bamnauli D/C (1000 mtrs.) and 400 kV Ballabgarh - Bamnauli D/C (1000 mtrs) for clearing the land associated with the 750 MW Pragati-II CCPP at Bamnauli.

The cable shall be laid in trench. The approximate length of cable trench shall be 1000 mtrs . Each phase of circuit consist double run of single core cable. There are 4 sets of cables and accessories ( 1 for each 400kV line). Each set comprising of six runs of single core cable of 1000m length for the 3 phases.

Cable trench section is enclosed with this specification.

Name of the Customer: **Pragati Power Corporation Limited (PPCL)**

Consultant : **NTPC Limited , Consultancy Wing**

Name of the Project: **750 MW Pragati CCPP at Bamnauli**

#### **A. SUPPLIES**

- I. Supply of power cable, Single core, Copper conductor compacted circular stranded, XLPE-insulated, Corrugated Aluminium sheathed, Black HDPE outer layer.
- II. Supply of cable accessories, essential spares, tools and tackles.

#### **B. INSTALLATION SERVICES**

Complete cable installation services including laying , termination, clamping , testing and commissioning of the cable system, point to point.

The Specification envisages turnkey execution of a COMPLETE, POINT TO POINT, 400 kV CABLE SYSTEM and the scope includes all materials and service necessary to execute the job to the satisfaction of PPCL/NTPC and BHEL. Any other item /service required for the execution for the complete job shall be included in the offer , Whether specifically mentioned in the specification or not, The Bill of quantities included in the offer shall clearly reflect such items along with their respective quantities.

**The exact requirement shall also be decided by supplier after visiting site & making precise measurements. The Payment of cables length will be as per actual measurement at site jointly.**

**Bidder shall offer both Supplies and Installation Services as per this Technical Specification. Bids in which only Supplies or only Installation Services are offered shall be rejected.**

#### 1.1 SPECIFIC TECHNICAL REQUIREMENTS-

Sl. no.	Particulars	Unit	400kV
1.	Rated System Voltage	kV	400
2.	Highest System Voltage	kV	420
3.	Number of phases	Nos.	3
4.	System Frequency	Hz	50 ± 5 %
5.	System earthing		Solidly grounded
6.	Rated Normal Current at nominal system voltage (400 kV)*	A(rms)	3150
7.	Rated peak withstand current	kA	100
8.	System fault current for one second	kA	40
9.	Rated withstand voltage to earth of cable and cable sealing		
	- One minute power frequency	kV	630
	- Lightning Impulse	kVp	1425
	- Switching Impulse	kV	1050
10.	Nominal cross section area of Conductor (Double Run)*	mm <sup>2</sup>	2500 (Minimum)
11.	Type of conductor		Copper
12.	Internal semiconductor		XLPE semi-conducting shield
13.	Insulation		XLPE
14.	External semiconductor		XLPE semi-conducting shield
15.	Metallic sheath*		Corrugated / Laminated Aluminium

Sl. no.	Particulars	Unit	400kV
16.	Outer sheath		Black HDPE
17.	Creepage distance for termination	mm/kV	25
18.	Maximum permissible operating temperature of the conductor at Rated continuous current	°C	90
19.	Short circuit Temperature (5 seconds max.)	°C	250
20.	Daily load	Hours	24
21.	Sheath voltage under full load condition to ground	V	65 (Max.)
22.	Laying method *	-	Flat formation, laying in trench (Drwg enclosed)
23.	Design ambient temperature	°C	50
24.	Minimum ambient temperature	°C	-4
25.	Type of bonding		Cross bonding

\* Bidder will submit short circuit current calculation, continuous current rating calculation and sheath standing voltage calculation for justifying the size of the 400kV cable.

## 1.2 QUANTITIES:

Material and Services required for the execution of the job are listed below. All item listed in the following BOQs shall be offered. Any item not appearing herein but clearly mentioned in Section 2 shall be included in the offer. The BOQs included in the offer to be submitted by the Bidder shall be exhaustive in this respect and shall cover completely the requirements of Section 1 and Section 2.

### SUPPLY AND ETC ITEMS

Sl. No	Description	Unit	Quantities
1.	Supply		
1.1	400 kV 1C X 2500*mm <sup>2</sup> Copper conductor corrugated/laminated Aluminium, XLPE cable	M	24000 (Twenty four lengths of 1000 m each, drum length 350 m)

S. N.	Description	Unit	Quantities
1.2	400 kV outdoor type cable termination kit complete in all respect terminating the above cable <b>along with support structure.</b>	Nos.	48
1.3	400 kV Cable Straight through joints for the above cable	Nos.	50
1.4	Accessories (Detailed description and bill of material shall be furnished)		
1.4.1	Link Box for Earthing	Set.	04
1.4.2	Link Box for Cross bonding	Set.	04
1.4.3	Earthing cable for earthing of cable termination kit	Lot	01
1.4.4	Cross Bonding cable	Lot	01
1.4.5	Non-magnetic Single type cleat clamps with necessary hardwares for fixing above cables to the Cable support system	Set.	04
1.4.6	24 cores Optical fiber cable in each circuit for protection communication and temperature sensor purpose along with Junction Box on both sides at an interval of 1000M.	M	4000
2	Services		
2.1	Installation, Testing and Commissioning of EHV Cable and Accessories (Item 1.1 & 1.4)	M	24000
2.2	Installation, Testing and Commissioning of 400kV outdoor type cable termination kit (Item 1.2)	Nos.	48
2.3	Installation, Testing and Commissioning of 400 kV Cable Straight through joints (Item 1.3)	Nos.	50
2.4	Installation, Testing and Commissioning of optical fiber cable for protection communication and temperature sensor purpose along with Junction Box on both sides at an interval of 1000M. (Item 1.4.6)	M	4000
3	Training		
3.1	Training for BHEL/PPCL personnel at supplier's works (14 man days)	Lot	01

**\* Bidder to confirm the suitability of size of the cable**

**Note:**

- (1) Manufacturing lengths and drum length shall be determined as per the joint route survey with PPCL, BHEL and the Supplier.
- (2) The exact length may vary by  $\pm 25\%$ .
- (3) Supplier will submit detailed bar chart indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning.
- (4) Earthing of HT cables shall be in supplier scope. 40 mm dia. MS Rod will be provided to interconnect yard and switchyard end. Any other items, other

than 40 mm dia. MS Rod , GI Flat if required to be supplied by the supplier and shall be clearly mentioned in the offer. The cables will be laid on Al. trays which will be earthed by providing MS Flat. The accessories shall necessary include the following but not limited to: SVL, Link box for earthing , Link box for cross bonding, Earthing cable, bonding cables etc as per the requirement.

(5) Support structure for cable sealing end shall be provided by bidder.

### 1.3 QUALIFYING REQUIREMENT & TYPE TESTS:

The bidder shall furnish the Test Reports of the Pre Qualification Tests as well as Type Test Reports of cable system (cable system consists of cable, straight through joint boxes and end termination) as per IEC 62067 from accredited laboratory (accredited by the national accreditation body of country where laboratory is located) to establish about its technical capability in manufacturing such class and/or joints and terminations. The alternative long term test/ demonstration of satisfactory service experience as per Note to clause 13.2 of IEC 62067 shall not be considered for this purpose. In case type test reports are more than 5 years old or the reports of type tests are found to be technically unacceptable, the type test shall be conducted by the vendor without cost and delivery implication to BHEL.

### 1.4 INSPECTION & TESTING

Before being fitted on the equipment, all components shall be subjected to routine tests at the Contractors factory, provided by the relevant IEC/IS standards. A detailed test report proving the successful passing of such tests shall be provided.

Prior to dispatch, the routine & acceptance tests shall be carried out on cables and accessories in accordance with the applicable IEC /IS and the material shall be offered for final inspection by BHEL and PPCL/NTPC in accordance with agreed quality plan with 3 weeks advance information.

Type test reports on identical rating cables and accessories shall be submitted for approval. In event of non-acceptability of submitted test reports on technical grounds at the contract stage, the type tests shall be conducted at no additional cost.

### 1.5 QUALITY PLAN

The contractor shall carry out the works in accordance with sound quality management principles which shall include such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Contractor shall submit detailed Quality Plan for BHEL / customer's approval.

## 1.6 SITE INFORMATION:

	Particular	Details
a)	Customer	Pragati Power Corporation Limited , Delhi
b)	Consultant	NTPC Limited , Consultancy Wing
c)	Project Title	750 MW Pragati CCPP at Bamnauli
d)	Location	Delhi
e)	Transport Facilities	By Road
SITE CONDITIONS		
a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient temp.	50°C
d)	Design reference temp.	31.7°C
e)	Max. RH	100%
f)	Min. RH	0 %
g)	Design reference RH	60 %
h)	Altitude	<500 MSL
i)	Pollution Severity	High Pollution level (25mm/kV)
j)	Seismic Zone	Zone-V As per IS 1893
WIND DATA		
a)	Wind velocity	47m/sec

## 1.7 Information to be supplied together with the bid:

At least the information listed hereunder shall be given by the Bidder. The Bidder may submit additional documents /descriptions to describe special technical features of offered equipments / system:

- 1 Drawing with cross-section of each cable type, showing construction and dimension.
- 2 Dimensional drawing of cable sealing ends of each type.
- 3 Propose applicable methods of cable testing after laying.
- 4 Describe proposed cable laying and fixing method including cross bending, if applicable.
- 5 Propose method of earthing of cable screens including sheath overvoltage protection measure, if applicable.
- 6 Bidder will submit short circuit current calculation, continuous current rating calculation and sheath standing voltage calculation for justifying the size of the 400kV cable in flat formation. Section of Trench is enclosed.
- 7 The cable trench and support angles in the trenches will be supplied by BHEL as per supplier's recommendation to be given at offer stage

## SECTION 2

### EQUIPMENT SPECIFICATION

#### 1.0 GENERAL

The section covers the broad technical specifications of 400kV single core Copper conductor XLPE insulated, Aluminium corrugated sheathed cable system complete with accessories and spares etc.,

#### 2.0 GENERAL REQUIREMENTS

The design and workmanship of the cable and accessories covered under this specification shall be in accordance with the best engineering practices to ensure satisfactory performance and service life of 50 years. The cable accessories shall also be designed for maximum reliability and acceptability.

Unless brought out clearly, the offer shall be deemed to confirm to this specification. Any deviation between this specifications and bid offered, if not clearly brought out and accepted by BHEL/PPCL will not be considered as availed deviation.

The vendor shall bring out clearly any additional feature which they deem to include to give a complete and comprehensive offer. The vendor shall, however sustain his reasons for offering such additional feature/item in his proposal.

#### 3.0 STANDARDS:

The XLPE Cables and the associated accessories shall conform to the following International standards, as amended/ revised till date, as appropriate:

IEC 62067	Power cables with extruded insulation and their accessories for rated voltage above 150 kV up to 500kV – Test methods and requirements.
IEC 60060 Part-1	High voltage test techniques
IEC 60187	General definitions & test requirements
IEC 60068	Seismic test methods for the equipment
IEC 60183	Guide to the selection of High Voltage Cables
IEC 60228	Conductors for insulated cables
IEC 60229	Tests on cable over sheaths
IEC 60230	Impulse test on cables and their accessories
IEC 60270	Partial Discharge Measurements
IEC 60287	Calculation of continuous current carrying capacity & losses



IEC 60332 Part-1	Test on Electric Cables under fire conditions
IEC 60502	Power Cables with extruded insulation and their accessories
IEC 60506	Switching Impulse test on EHV Insulators
IEC 60540	Test methods for insulations and sheaths of electric cables and cords
IEC 60811 Part-1 to Part-4	Common test methods for insulating and sheathing materials of electric cables
IEC 60840	Tests for power cables with extruded insulation
IEC 60859	Cable connections for gas insulated metal enclosed switchgear
IEC -60885 Part-3	Electrical test methods for electric cables
IEC 62087	
CIGRE WG21.03 (Electra 151) (Dec 1993)	Recommendation for electrical tests on extruded cables and accessories
IEEE 48	Test procedures and requirements for high voltage cable terminations
IEEE 404	Joints for use with solid dielectric cables
IEEE 635	Guide for selection and design of aluminium sheath

#### 4.0 GENERAL TECHNICAL REQUIREMENTS OF CABLE:

- 4.1 The cable and all its accessories shall conform in all respects, to the requirement of the latest standards of IEC except in so far as they are modified in these specifications. Whenever a standard is specifically mentioned in the specification, it is understood that the corresponding standard or standard from amongst the source mentioned above shall also apply. It is, however, understood that the cable and accessories etc., supplied shall conform to one consistent set of standards except in so far as they are modified by the requirement of these specifications.
- 4.2 Cables/Cable accessories satisfying the quality requirements of other International standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the supplier conforms to other standards, salient points of difference between the standards preferred and the specified standards shall be informed. Four (4) copies of the reference standards in English language shall be furnished for reference.

- 4.3 The general principle on which these specifications are drawn up, is to permit the adaptation of modern manufacturing standards. The Contractor shall supply his own standard equipment as far as possible, provided they comply with the requirements of these specifications. However, should the Contractor wish to depart from the provisions of these specifications either on account of manufacturing practice or for any other reasons, he shall draw the attention of the Corporation to the proposed items of departure and shall submit such full information, drawings and specifications, full justification as will enable the relative merits.
- 4.4 In the event of these specifications or part thereof and of the Contractor's drawings, specifications, forms, tables etc., being found to disagree during the execution of the contract, these specifications shall be held as binding unless, the departures have been duly approved in writing by the Corporation.
- 4.5 All similar component parts of similar equipment supplied shall be interchangeable with one another.
- 4.6 Triple Extrusion:  
The conductor screen, insulation and insulation screen shall be extruded in single process (triple extrusion) and cross linked by continuous vulcanization process or MDCV process (Mitsubishi Dainichi Continuous Vulcanization process) or any other equivalent process using dry curing technology to ensure homogeneity and absence of micro voids.
- 4.7 The cable shall be designed to have a minimum useful life of not less than fifty years.
- 4.8 Each cable length shall be provided with a pulling socket, pulling eye, which shall be fitted to pulling end to withstand the maximum pulling force.
- 4.9 The contractor shall furnish the details of any specific construction features which will be provided to ensure specific water tightness of cable both transversely and longitudinally.
- 5.0 MECHANICAL CHARACTERISTICS OF CABLE:**
- The cable shall withstand the electro-mechanical forces due to short circuit current of 40 kA and shall withstand the stresses in the insulation due to faults. The cable shall withstand the mechanical stress during installation.
- 5.1 TEMPERATURE RISE:**
- The maximum conductor temperature shall not exceed 90°C during continuous operation of current. The temperature after a short circuit for one second shall not exceed 250° C, with initial conductor temperature of 90° C.
- 5.2 CABLE MATERIAL:**
- a) **Conductor** :The conductor shall be of plain annealed high conductivity copper wires, stranded, segmental conductor conforming to IEC-60228. The Copper used for the conductor shall be of highest purity. The minimum number of wires and conductors and DC resistance of conductor shall be as per IEC-60228.

**b) Conductor Screen :** The conductor screen shall be provided over the conductor by extrusion of semi-conducting compound or by a combination of semi-conducting tape/s and extruded semi-conducting compound.

**c) Insulation :** Cross-linked polyethylene insulation by dry curing process shall be provided over the conductor screen. The insulation shall be of high quality and shall be as far as possible free from contaminants, moisture and voids. The size of voids and contaminants shall be within limits of recognised Standards.

The insulation shall be suitable for operation in wet or dry locations at conductor temperature not exceeding 90° C for normal operation and 250° C for short circuit conditions.

**d) Insulation Screen:** Shall be by extruded semi-conducting compound. The semi-conducting screen shall be suitable for the operating temperatures of the cable and compatible with the insulation.

**e) Moisture Barrier (Longitudinal):** This shall be semi-conducting synthetic non-woven tape with suitable swellable absorbent for longitudinal water sealing covering the whole surface area of the non-metallic part of insulation screening. This barrier shall restrict longitudinal water penetration under the metallic sheath. Similarly, suitable arrangement shall be provided for restricting the longitudinal water penetration along the conductor.

**f) Metal Sheath/Moisture Barrier (Radial):** This shall be Corrugated Aluminium sheath. The nominal thickness of sheath shall meet the Electrical and Mechanical properties as per standards. The minimum thickness shall be as per IEC-62067.

**g) Bedding Tapes:** Suitable semi-conducting bedding tapes shall be used under metallic screen.

**h) Metallic Screen (Armour):** The metallic screen shall be of non-magnetic SS316 stainless steel tapes or 1% bronze tapes/ plain copper round wires, helically applied over the semi-conducting bedding tape/s.

A binder tape of suitable material/annealed plain copper shall be applied in the form of an open helix, over the metallic screen.

**Note: Requirement of Metallic Sheath/Screen:**

The cross section of the metallic sheath that is corrugated Aluminium sheath in combination with stainless steel tapes/bronze tapes/plain copper round wire screen shall be designed to meet the following requirements:

i) Sustaining the system short circuit rating of 40 KA for 1 Sec. The temperature of metallic sheath at the time of short circuit (cable operating at maximum conductor temperature) shall be indicated in the short circuit calculations of the design of metallic screen/sheath.

ii) Ensuring mechanical protection of the cable.

iii) Ensuring radial water tightness of the cable.

Test report ensuring the above compliance shall be furnished by the contractor.

**i) Outer Sheath:** The outer sheath shall be extruded black colour, High Density Polyethylene, type ST7 conforming to requirement of IEC. The High Density Polyethylene compound used shall be brand new from a reputed manufacturer and in no case shall recycled material be used.

The Corporation reserves the right to seek documentary proof of the source of material

(insulation, outer sheath and other cable components) and to cross check with the supplier.

The outer sheath shall be designed for protecting against termite and rodent attack by adding suitable additives, which are harmless to operating personnel to High Density Polyethylene (HDPE) compound.

j) **Coating:** A hard baked one layer of graphite shall be applied over the outer sheath as outer electrode for testing sheath.

## 6.0 IDENTIFICATION:

The following information shall be embossed on the outer sheath of the cable continuously repeated through out the length of the cable.

- i) Brand Name of Manufacturer
- ii) Year of Manufacture
- iii) Voltage rating/conductor cross Section
- iv) Customer:
- v) XLPE
- vi) Running length of cables

The embossed letters and figures shall be raised and consist of upright block characters along one or more lines.

The maximum size of the characteristics shall be 20 mm and the minimum size not less than 15 percent of the nominal or specified external dia of cable or 3 mm whichever is greater

The gap between the end of one set of embossed characters and the beginning of the next shall not exceed 1 m. Any additional information embossed on the sheath shall not affect the spacing between repetitions of the legend.

Further as a safety if any additional ground wire is required for grounding all clamping equipment at ground potential shall also be supplied.

## 7.0 CABLE END TERMINATIONS:

- a) The cable end termination shall be outdoor type on both end suitable for cable size as specified in section-1 and shall conform to the relevant IEC.
- b) The outdoor termination should have a device for electrical stress control at the end of screen/shield. It should avoid partial discharges and surface Corona under the service conditions. It should seal any ingress of atmospheric elements. The total creepage distance shall not be less than 25 mm/kV.
- c) The terminations shall be suitable for insulation voltage, conductor size and current rating of the cable.
- d) Cable terminations (Sealing end pre-moulded type) – The sealing ends shall conform to the latest International Standards and shall be of thoroughly proven design. The internal electric stress by the pre-moulded cone epoxy resin unit arrangement preferably with epoxy bell mouth and all other accessories. The cable terminations shall be outdoor type. The outdoor type sealing end shall be suitable for installation in polluted atmosphere and shall be completely weather proof. Each outdoor type sealing end shall be supplied complete with mounting plate insulators to insulate the sealing end from the supporting structures and to control the sheath current. Each sealing end shall be provided with consumable

materials such as viper and cleanant for cleaning. The power cable leading to sealing end shall be provided with proper sunshield cover.

- e) The material for the housing of the termination should be resistant to tracking, ultra violet radiation (U-V exposure) weathering and should have stable hydrophobic properties.
- f) The contractor shall provide necessary arrangement to limit flow of current in the structure supporting the sealing end.
- g) The sealing ends shall withstand the power frequency, impulse and cable testing voltage after installation as specified.
- h) The cable and accessories shall withstand all thermal and mechanical stresses under steady state and transient operating conditions.

#### **8.0 SUPPORTS, HARDWARES AND ACCESSORIES:**

- (a) The supporting structure ( in bidder scope) for the outdoor shall be fabricated from lattice steel structure along with detailed foundation design and drawing shall be furnished by the successful bidder. The Contractor shall furnish necessary information such as foundation load and mounting details to the Corporation.
- (b) Cable cleats, clamps, fixing bandage, miscellaneous accessories and hardware required for the assembly of the cable support system shall be supplied. The complete detailed fixing arrangement/ installation drawings of the cables shall be furnished.

#### **9.0 PROTECTION AGAINST EARTH QUAKE:**

Cable system shall be so designed as to be secured to the foundation clamps to withstand earthquake forces of the above.

#### **10.0 CABLE DRUMS**

Immediately after the inspection, both ends of each cable length shall be sealed by means of end caps in the presence of the inspector. Cable drums shall be of rugged construction, with a drum diameter of ample dimensions to accommodate the single-conductor cables. The drum cable length shall be chosen considering the lengths to be laid at site. No negative tolerance on the required lengths may be adopted.

Each drum shall be marked, by stenciling thereon, with an arrow the direction in which the drum should be rolled. The cable shall be wound on non-returnable strong steel drums. The dimensional drawings of steel drums shall be furnished. The drum shall be provided with circumferential lagging of strong wooden planks. The ends of the cable shall be sealed with good quality heat shrink sealing caps. The required additional sealing caps of sufficient quantity shall be supplied for use for testing during laying at site and to seal spare lengths of cable.

The cable drums shall be supplied with definite cable length ( to be informed before start of manufacturing ) within  $\pm 2$  m tolerance. Contractor shall not be reimbursed for excess lengths supplied. Cable drums with shorter lengths shall not be accepted.

## 11.0 INSTALLATION & COMMISSIONING

Cable drum shall be unloaded, handled and stored on hard and well drained surface so that they may not sink. In no case, the drum shall be stored flat i.e. with horizontal. Rolling of drums shall be avoided as far as possible. For un-reeling the cable, drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that the cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall always be kept sealed by heat shrinkable PVC caps to prevent damage and ingress of moisture.

While laying the cable, power rollers shall be used at required interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangement. Pulling tension shall not exceed recommended values. Selection of cable drum for each run shall be planned so as to avoid using straight through joint. Cable splices will not be allowed unless approved by customer.

The cables shall be laid and terminations installed by skilled and experienced workers, fully qualified to carry out the work. The supplier shall also be responsible for providing clamps, required to support cables on racks for cable laying in trenches.

In surface trench, cable will be laid in trefoil arrangement on support angle and will be fixed with angle by clamps made of non-magnetic material. These surface trenches will be covered by suitable trench covers.

The sheath voltage under full load conditions shall be within safe limits. The value of sheath voltage shall be furnished for approval. Sheath shall be solidly grounded at both end. The connection to earth shall be as short as possible to prevent HV impulses and spikes. A sheath voltage limiter shall be provided as per section-1 to control the sheath voltage. These voltage limiters shall be without boxes.

## 12.0 TESTS

The cables and cable terminations shall be subjected to tests as per applicable standards in the presence of PPCL/BHEL and/ or their authorized representatives. After installation, the cables shall also be subjected to tests at sites. All tests shall be carried out generally as per the different standards listed in Cl. 3 above. Following test but not limited to this as mentioned below shall be conducted as per latest IEC.

### 12.1 TYPE TESTS (IEC 62067)

The Supplier shall conduct the type tests as per relevant IEC standards at no extra cost to customer. The supplier shall offer material for selection of samples for type testing, only after getting quality assurance plans approved. The sample shall be manufactured strictly in accordance with the approved Quality Assurance Plan.

Type tests shall be carried out as per IEC, if type test report are not valid/approved.

The list of type test is as follows :

- a) **Electrical type test on complete cable system (CI 12.4)**
  - i) Check for insulation thickness of cable for electrical type test (CI 12.4.1)
  - ii) Bending test (CI 12.4.4)
  - iii) Partial discharge test (CI 12.4.5)
  - iv) Tan  $\delta$  measurement (CI 12.4.6)
  - v) Heating cycle voltage test (CI 12.4.7)
  - vi) Lightning impulse voltage test followed by a.c. voltage test (CI 12.4.9)
  - vii) Examination (CI 12.4.10)
  - viii) Resistivity of semi-conducting screens (CI 12.4.11)
  - ix) Switching impulse voltage test (CI 12.4.8)
- b) **Non electrical type test on cable components and on complete cable (CI 12.5)**
  - i) Check of cable construction (CI 12.5.1)
  - ii) Tests for determining the mechanical properties of insulation before and after ageing (CI 12.5.2)
  - iii) Tests for determining the mechanical properties of oversheaths before and after ageing (CI 12.5.3)
  - iv) Ageing tests on pieces of completed cable to check compatibility of materials (CI 12.5.4)
  - v) Loss of mass test on PVC sheaths of type ST2 (CI 12.5.5)
  - vi) Pressure test at high temperature on oversheaths (CI 12.5.6)
  - vii) Test on PVC oversheath ST2 at low temperature (CI 12.5.7)
  - viii) Heat shock test on PVC oversheath ST2 (CI 12.5.8)
  - ix) Hot set test for XLPE insulation (CI 12.5.10)
  - x) Test under fire conditions (CI 12.5.13)
  - xi) Water penetration test (CI 12.5.14)

## **12.2 Acceptance Tests (Sample Tests) on Cables (CI. 10 of IEC 62067)**

Following tests shall be carried out on minimum 10% of the drums subject to minimum one sample in each lot :

- a) Tests on conductor (CI 10.4 & 10.5)
- b) Measurement of thickness of insulation and oversheaths (CI 10.6)
- c) Measurement of thickness of metallic sheath (CI 10.7)
- d) Measurement of diameters (CI 10.8)
- e) Hot set test for XLPE insulation (CI 10.9)
- f) Measurement of capacitance (CI 10.10)
- g) Lightning impulse voltage test followed by power frequency voltage test (CI 10.12)

## **12.3 SAMPLE TESTS ON ACCESSORIES**

Tests and its procedure to be proposed by the supplier for GSECL/BHEL's approval.

## **12.4 ROUTINE TESTS**

Following routine test shall be carried out as per Clause 9 of IEC 62067 on samples drawn from each drum and each accessory:

- a) Partial discharge test (CI 9.2)
- b) Voltage test (CI 9.3)
- c) Electrical test on non metallic sheath of the cable (CI 9.4)
- d) Voltage test on outer sheath as per Clause 3.1 of IEC 60229

## 12.5 SITE TESTS

The suppliers shall furnish field quality assurance plans giving different checks and tests, including high voltage tests, to be carried out at site to ensure a maintenance-free installation. Atleast following site test shall be carried out as detailed in Clause 14 of IEC 62067.

- a) DC voltage test of the oversheath (CI 14.1)
- b) AC voltage test of the insulation by applying a voltage  $U_0$  to be applied for 24 hours (CI 14.2) –

## 13.0 DESIGN REQUIREMENTS

Supplier of the cable system shall furnish the details calculations along with technical data sheet for verification/approval of design parameters elected. Detail design calculations/documents will be submitted for approval to PPCL/BHEL:

- a) Calculation of continuous current capacity for specified cable laying conditions
- b) Adequacy of XLPE insulation thickness.
- c) Calculation for short circuit currents for metal sheath or screen.
- d) Calculation for adequacy of metallic sheath/ screen for short circuit current carrying capability.
- e) Calculation of sheath induced voltage for cross bonding.
- f) Manufacturing Quality plan
- g) Field quality plan for site installation, commissioning and testing
- h) Instruction manual for jointing and cable laying.

## 14.0 PACKING AND MARKING

The packing should be able to withstand the rigors of transport.

The following information in bold letters in English shall be painted on the flanges.

- (i) Name and address of the Manufacturer, Trade name/Trade Mark/Brand.
- (ii) Size of cable (cross section) rated voltage, standard, insulation, cable code, drum number, year of manufacture.
- (iii) Length of cable (metres)
- (iv) Direction of Rolling
- (v) Net weight (in Kg)
- (vi) Gross weight (in Kg)
- (vii) Purchase order reference.



## Section -3

### Guaranteed Technical Particulars

Item / Clause No.	Parameter	Units	Contractor's Data
1	Type designation	-	
2	Rated system voltage	kV	
3	Highest voltage for equipment Um	kV	
4	Rated frequency		
4.1	Normal condition	Hz	
4.2	Exceptional condition	Hz	
5	Rated power frequency withstand voltage	kVrms	
6	Rated lightning impulse withstand voltage (1.2/50ms)	kVpeak	
7	Rated switching impulse withstand voltage	kVpeak	
8	15 minute dry power frequency withstand test voltage (conductor-sheet)	kVrms	
9	Maximum partial discharge	pC	
9.1	At test voltage	kVrms	
10	Test voltage after laying, applied on complete installation (cable and cable end seals)	kV	
11	Maximum permissible operating temperatures at		
11.1	Continuous rated operation	°C	
11.1.1	Short time emergency (overload) operation	°C	
11.1.2	Short-circuit condition	°C	
12	Cable construction		

Item / Clause No.	Parameter	Units	Contractor's Data
12.1	Conductor cross section	mm <sup>2</sup>	
12.2	Conductor design	-	
12.3	conductor material	-	
12.4	Type of screen	-	
12.5	Screen cross-section	mm <sup>2</sup>	
12.6	Screen material	-	
12.7	Thickness of XLPE insulation	mm	
12.8	Thickness of outer PE-sheath	mm	
12.9	Outer diameter of cable	mm	
12.10	Minimum bending radius	mm	
12.11	Weight of cable	kg/m	
13	Cable rating		
13.1	Rated continuous current considering specified cable laying	A	
13.2	Short time withstand current 1s		
13.2.1	Of conductor	kArms	
13.2.2	Of screen	kArms	
13.3	Dynamic short circuit withstand current	kApeak	
13.4	DC resistance at 20°C		
13.4.1	Of conductor	Ohm/km	
13.4.2	Screen	Ohm/km	
13.5	AC resistance of conductor at 60°C	Ohm/km	
13.6	Capacitance per phase	nF/km	

Item / Clause No.	Parameter	Units	Contractor's Data
13.7	Total cable losses at rated current, considering proposed screen earthing		
13.7.1	Per phase	kW/km	
13.7.2	Complete three phase system	kW/km	
14	Outdoor cable sealing ends		
14.1	Type designation	-	
14.2	Material of screens	-	
14.3	Number of sealing ends	-	

## Informative Data

Item / Clause No.	Parameter	Units	Contractor's Data
1	Manufacturer		
2	Place of manufacture		
3	Applicable standards		
4	Maximum electric field strength at the conductor at 440 kV (highest system voltage)	kV/mm	
5	Charging current per phase at 440 kV	A/km	
6	Inductance per phase	mH/km	
7	Induced voltage on screen		
7.1	At rated current	V/km	
7.2	at short circuit current	V/km	
8	Proposed cable laying		
8.1	Laying in	-	
8.2	Maximum ambient temperature	°C	
8.3	Arrangement of single phase cables	-	
8.5	Axial distance	mm	
8.6	Number of parallel circuits	-	
8.7	Joints required	yes/ no	
9	Total estimated length of single phase cable	m	
10	Maximum weight of complete cable drum for transportation	kg	
11	Maximum dimension of cable drum		
11.1	Diameter of drum	mm	
11.2	Width of drum	mm	

Item / Clause No.	Parameter	Units	Contractor's Data
11.3	Max. cable length per drum	m	
12	Manufacturer		
12.1	Outdoor cable sealing ends		