

Project: 400/220 kV GIS Substation at Ersama, Paradeep, Odisha  
Customer: Odisha Power Transmission Corporation Limited (OPTCL)  
Name of Item: 38/ 66kV XLPE cable & its accessories  
Ref. No. OPTCL/XLPE Cable/PQR REV 00

TECHNICAL QUALIFICATION REQUIREMENT
The bidder should have manufactured, supplied and commissioned/ supervised the commissioning of type tested single core 66kV or higher grade XLPE insulated cable of at least 1 Kilometer cable length in a single contract and which must have been in satisfactory operation# for at least 02 (two) years as on the original scheduled date of technical bid opening of this tender.

Requisite documents for ROUTE

SUPPORTING DOCUMENTS TO BE SUBMITTED BY BIDDER ALONG WITH TECHNICAL BID		
Sr	Required Criteria	Supporting Documents
1	Manufacturing	Approved Drawings/ GTP /Approved Quality Plan/ Factory Inspection Test Report etc. establishing bidder as manufacturer of offered item in line with TQR.
2	Supply	PO/ Dispatch clearance/ LR/ Material Receipt certificate at site/ installation or commissioning certificate etc. establishing bidder as proven supplier of offered item in line with TQR
3	Type Test	TTR approval from customer / Type Test Report etc. establishing successful type tested design in line with TQR
4	#satisfactory operation	Successful operation means certificate issued by employer/end-customer or main contractor (along with chain of document from employer/end-customer) stating successful operation without any adverse remark.

*Prakash Kumar*  
23/2/24

PREPARED BY

*Prakash Kumar*  
23/2/24

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23.2.24.

APPROVED BY



**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION BUSINESS ENGINEERING MANAGEMENT**  
 NOIDA

DOCUMENT NO.	TB-420A-316-007C	REV 00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	BY	AK	VK
Title: 38/66kV XLPE Cable & accessories (Suitable for coastal areas)	SIGN	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>	
	DATE	22.02.2024	22.02.2024	22.02.2024	
	GROUP	TBEM			
	WO No.				

CUSTOMER	ODISHA POWER TRANSMISSION CORPORATION LIMITED
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PROJECT	400/220 kV GIS SUB STATION AT ERSAMA, PARADEEP, ODISHA
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Remarks: Bidder to note that data and details of Annexure-D (Guaranteed Technical Particulars) shall not be reviewed during technical evaluation/ scrutiny, hence compliance of guaranteed technical particulars in line with technical specification shall be bidder's responsibility.

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Rev. No.	Date	Altered	Checked	Approved	
Distribution				To	
				Copies	

### CHECKLIST FOR TECHNICAL EVALUATION

Along with the technical offer/ bids, the bidder should submit this checklist confirming the inclusion of the enclosures as listed below,

Sl. No.	Documents to be enclosed	Bidder to confirm (Please tick "Confirmed")
1.	Supporting documents for compliance of Technical Qualifying Requirement.	Confirmed
2.	Unpriced BOQ duly mentioning "Quoted" for all the items, signed and sealed.	Confirmed
3.	Annexure- A duly signed and sealed & Annexure- B duly filled, signed and sealed.	Confirmed

Note: Any bidder not meeting the above requirement shall be liable for non-evaluation. The above checklist is reviewed and verified for,

NIT Reference No.:

Name of Bidder:

Name of Project: **OPTCL, Ersama, Paradeep, Odisha**

Date:

Bidder's Stamp & Signature

# Bharat Heavy Electricals Limited

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### SECTION 1:

#### SCOPE, PROJECT SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES

##### 1. Scope

This technical specification covers the requirements of design, manufacture, inspection including third party inspection and testing at manufacturer's work before supply, proper packing and delivery to project site and supervision of installation only and commissioning of equipment **(38/66kV XLPE Cable & accessories)** complete with all fittings, accessories and mandatory spares complete in all respects for efficient & trouble-free working mentioned under this specification.

This section covers the specific technical requirements of equipment. This constitutes minimum technical parameters for the above item as specified by the BHEL/ OPTCL. The offered equipment **(38/66kV XLPE Cable & accessories)** shall also comply with the Section-3 (Project Details and General technical requirements for all equipment under the Project) of this specification.

The specification comprises of following sections:

Section-1	:	Scope, Project Specific Technical Requirements & Bill of Quantities
Section-2	:	Equipment Specification under scope of Supplies/ Service
Section-3	:	Project Details & General Technical Requirements (For All Equipment under the Project)
Section-4	:	Annexures
		Annexure-A: Compliance Certificate to Technical Specification
		Annexure-B: Deviation/ Change Request to Technical Specification

The following order of priority shall be followed. In case of conflict between requirements specified in various documents, the more stringent one shall be followed. BHEL/ OPTCL concurrence shall, however, be obtained before taking a final decision in such matters.

##### 1. Statutory Regulations

In particular, the latest version of the following statutory regulations, as applicable, shall be followed for system,

- o Indian Electricity Act
- o CEA regulations
- o The Factory Act
- o Requirements of other statutory bodies as applicable, e.g. CEA etc.

##### 2. Section-1

##### 3. Section-2

##### 4. Section-3

##### 5. Codes & Standards

Bidder shall furnish list of conflicts/ ambiguities/ deviations, if any, along with their technical offer and also furnish the basis that is considered for submitting technical offer. BHEL/ OPTCL will resolve listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL/ OPTCL of their interpretation. In case bidder fails to convey the same prior to award, BHEL/ OPTCL decision on interpretation shall be considered final if need arises during the execution. No additional cost or extra time on account of conflicts/ ambiguities/ deviations shall be admissible.

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In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer (Annexure-A), however bidder shall furnish list of conflicts/ ambiguities/ deviations (Annexure-B), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

The equipment is required for the following project:

Name of the Customer : **Odisha Power Transmission Corporation Limited**  
Name of Main Contractor : **Bharat Heavy Electricals Limited**  
Name of the Project : **400/220KV GIS Sub Station at Ersama, Paradeep, Odisha**

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry.

### 2. Codes & Standards

1. The rating as well as performance and testing of the equipment shall comply with the latest editions and amendments of the following standards as applicable, unless otherwise specified elsewhere in this specification,
  - IEC 60840 Power cables with extruded insulation and their accessories for rated voltages above 30 kV ( $U_m = 36$  kV) up to 150 kV ( $U_m = 170$  kV) - Test methods and requirements
  - IEC 62067 Power cables with extruded insulation and their accessories for rated voltages above 150 kV ( $U_m = 170$  kV) up to 500 kV ( $U_m = 550$  kV) - Test methods and requirements
  - IS 3043 Code of practice for earthing
  - IS 5831 PVC insulation and sheath of electric cables
  - IS 7098 Cross-linked Polyethylene Insulated PVC Sheathed Cables
  - IS 8130 Conductors for Insulated Electric Cables and Flexible Cords
  - IS 10810 Methods of Test for Cables
2. For the purpose of this specification all technical terms used hereinafter shall have the meaning as per IEC/ ISS specification.
3. The equipment meeting with the requirements of other authoritative standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the bidder confirms to other standards, salient points of difference between the standards adopted and the specified standards shall be clearly brought out in the offer.
4. In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent or stringent than the applicable Indian standards.
5. The equipment shall also conform to the provisions of Indian Electricity Rules, 1956 and other statutory regulations currently in force in the country.
6. In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

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### 3. Specific Technical Requirements

1. The equipment shall perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
2. The equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.
3. The equipment shall also comply with the following,
  - a. To facilitate erection of equipment, all items to be assembled at site shall be “match marked”.
  - b. All piping, if any between equipment control cabinet/ operating mechanisms to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.
4. In addition to this, the other specific technical requirements for the equipment shall be as follows,

Sl. No.	Particular	Unit	Data
1.	Voltage grade of cable	kV	38/66
2.	System	-	33kV Unearthed
3.	Highest System Voltage	kV	52
4.	System frequency	Hz	50
5.	Codes & Standards	-	Latest editions of IEC 60840/ IS 7098-part3 (applicable clauses only) for construction and IEC 60840/ 62067 (as applicable) for testing of XLPE cable. Latest editions of IEC62067 (as applicable) for terminations/ joints
6.			
7.	System Power Frequency Withstand Voltage	KV	95
8.	Lightning Impulse Withstand Voltage of required cable	kVp	250
9.	Creepage distance	mm/kV	31
10.	Ambient air temp.	Deg. C	50
11.	System Short Circuit Withstand Current at a rated voltage	kA	31.5 for 3 sec
12.	Single core/ Multi core	-	Single core
13.	Conductor size of cable	Sqmm	240
14.	<b>Conductor</b>		
a)	<b>Conductor material</b>		Copper conductor of IS 8130, stranded copper conductor
b)	<b>Conductor screen</b>		Extruded semi conducting compound
i)	Minimum thickness	-	As per IS 7098- part3
15.	<b>Insulation</b>		
a)	Material		Extruded XLPE compound to IS 7098 -

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Sl. No.	Particular	Unit	Data
			part3
b)	Continuous Withstand Temperature (For insulation)	Deg C	90
c)	Short Circuit withstand Temperature (For insulation)	Deg C	250
d)	Nominal thickness		As per IS 7098- part3
16.	<b>Insulation screen</b>		
a)	Material		Extruded Semiconducting compound
b)	Minimum thickness		As per IS 7098- part3
17.	<b>Metallic sheath</b>		
a)	Material		Lead alloy 'E' sheathed
18.	<b>Metallic screen</b>		
a)	Material		Helically applied Annealed Plain Copper wires with annealed plain copper tape as open helix (binder)
b)	Earth fault current requirement of metallic screen + metallic sheath		31.5kA for 1 sec
19.	<b>Outer sheath</b>		
a)	Material		Extruded HDPE type ST-7 compound (black)
b)	Conductive layer over HDPE sheath		Extruded semiconducting layer
20.	Standard Drum length	M	500/1000, steel
21.	Drum marking		Owner's identification mark i.e. "OPTCL" and "BHEL-TBG", Manufacturer's name and /or trade mark, Type of Cable & Voltage Grade, year of manufacture, Type of insulation, No. of core & Cable size, cable code, length of cable on drum, No. of length on drum (if more than one), direction of rotation (by arrow), approx. gross mass, IS/IEC number and ISI mark.
22.	<b>Tolerance</b>		
a)	Tolerance on OD		±2 mm over the declared value in data sheet
b)	Tolerance on individual drum length	-	±5%
c)	Overall tolerance on total dispatched quantities	-	(+) 2%

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Sl. No.	Particular	Unit	Data
23.	<b>Type of outdoor cable termination</b>	-	Heat Shrinkable outdoor
24.	Cable Laying	-	Trench/ pipe
25.	Termination of cable	-	Towards transformer/ ICT side- Termination kit connection in tertiary cable box Towards Station Transformer- Termination kit connection with HT terminal
26.	Laying conditions		
27.	Cable Laying		Cable racks in cable trench in flat formation
28.	Earthing of screen		Single point/ cross bonding
29.	-Transformer/ ICT end		Solidly earthed link box without SVL (sheath voltage limiter).
30.	-Switchyard end		Solidly earthed link box with SVL (sheath voltage limiter)
31.	Type of atmosphere		Coastal, high ambient, humid & tropical

Notes:

- (i) \*Vendor shall furnish calculations of cable for following,
  - (a) Screen/ sheath voltage under full load condition,
  - (b) Screen/ sheath voltage during an external three phase symmetrical through-fault.
- (ii) Vendor shall furnish calculations for screen/ sheath voltage/ current and the recommended method for metallic screen bonding, i.e. single point/ cross bonding.

#### 4. Other General Requirements

The other general requirements for the equipment shall be as follows,

1. Store
  - a. Open/ closed store area shall be provided by BHEL, however, bidder shall provide their requirement of space in open store during tender stage only. In addition to this, bidder shall also provide their standard recommendations for precautions to be taken during unloading and storage etc. for approval of BHEL/ OPTCL.
  - b. Office facilities & accommodation for bidder's staff along with conveyance, transportation of all special tools & plants, testing kits etc. shall be in bidder's scope.
2. Installation of cable trays, cable rack assembly along with Earthing
  - a. The cables shall be laid in cable trays fixed on cable racks assembly in cable trench, as per site requirement. Cable racks assembly in cable trench shall be supplied and fixed by BHEL based on detailed input design and drawing provided by bidder.
3. Termination and Jointing
  - a. Tools & tackles, testing instruments/ kits required for carrying out termination/ jointing works shall be bidder's scope.
  - b. Any cable or accessories damaged during installation, testing & commissioning shall be

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made good/ repaired/ replaced by bidder to the satisfaction of BHEL/ OPTCL.

4. Site Testing & Commissioning
  - a. Bidder shall depute its qualified testing & commissioning engineer including supply of all testing instruments/ kits (DC test for outer sheath and HV test).
  - b. Bidder shall submit complete methodology for conduction of site tests for further approval of BHEL/ OPTCL.
5. Construction supply

For construction purpose, the necessary power supply at site shall be provided by BHEL at one point only, however supply requirements for testing etc. shall be arranged by bidder only.
6. Site Supervisor and Jointer
  - a. Termination/ jointing of cables shall be done by skilled and experienced jointer certified by OEM of the joints/ end terminations and duly approved by Engineer-in charge.
  - b. Provision of site supervisor and skilled technician, qualified jointer etc. along with tools & tackles, testing instruments/ kits etc. shall be deemed to be included in bidder's scope.
7. Any special tools and tackles required to complete the cable installation/ laying, termination, testing and commissioning etc. shall be included in the offer. However, general tools and tackles for laying of cables shall be provided by BHEL.
8. The bidder must fill up all the details required for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in.

### 5. Bill of Quantities

1. Quantities for supply and services for the equipment shall be as per **ANNEXURE- BOQ for 38/66kV XLPE cable & accessories**. However, any item/ service not appearing herein but required for completeness of the work is deemed to be included in bidder's scope.
2. Bidder may please be noted that the exact cable length shall be decided after visiting site & making precise measurements at contract stage. Manufacturing lengths and drum length shall be determined with consultation & approval with BHEL/ OPTCL.
  - a. The Payment of cables length for supply shall be as per approved quantities by BHEL/ OPTCL.
  - b. The Payment of cables length installation will be as per actual measurement at site which shall also include cable terminations.
  - c. The quantity variation shall be **±20%** at contract stage based on actual measurement at site and calculations submitted by the bidder. Individual quantity of other items may vary to any extent and may get deleted during contract/ execution stage.

### 6. Drawings / Documents required for Engineering Manufacturing Clearance

The drawings/ documents, as follows shall be used for providing engineering manufacturing clearance of the equipment and furthermore, it shall be used for delay analysis, if any from bidder.

1	EHV Cable- Cable Cross Section Drawings with Guaranteed Technical particulars
2	EHV Cable- Cable Cutting & Cable Drum Schedule

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3	EHV Cable- OGA Drawing with Guaranteed Technical particulars of Termination Kits
4	EHV Cable- OGA Drawing with Guaranteed Technical particulars of Straight Through Joints
5	EHV Cable- Quality Assurance Plan & Inspection Test Schedule of HV Cable & its Accessories

### 7. Type Testing

Bidder shall ensure that the equipment being procured should have valid type test certificates as per specified in IS/ IEC standards (amended up to date) at any NABL accredited laboratories.

The validity of type test reports shall be as per the latest CEA guidelines for the validity period of type test(s) conducted on major electrical equipment in Power Transmission system. In case the item/equipment is not listed in the CEA guidelines, the validity of the respective items/ equipment shall be as per TS.

In case any of Type tests have not been conducted on the offered design or there has been a change in the design after the type tests. The requisite tests shall be conducted by bidder on the offered design without any extra cost and delivery impact to BHEL/ Customer.

All type tests and additional type tests for improved fire performance shall be carried out as listed in IS: 7098 (Part-2)/ IEC as applicable on XLPE insulated cables, however type tests shall be carried out to prove the general qualities and design of a given type of termination / jointing system as per IS-13573/ IEC as applicable for Accessories.

All cable termination kits shall be of proven design and type tested as per relevant standard. Type test certificates/ specific type tests shall furnished/ conducted, if asked for with reference to any specific equipment in the respective sub-section of the Specification.

### 8. Quality Plan

The successful bidder shall submit Quality Assurance with in-process inspection methods, tests, records, etc. for BHEL/ OPTCL approval. Customer hold points will also be included in the plan, which shall be mutually agreed by the BHEL/ OPTCL. In case bidder has reference, Quality Assurance Plan agreed with BHEL/ OPTCL, same shall be submitted for specific project to BHEL/ OPTCL approval. There shall be no commercial implication to BHEL/ OPTCL on account of Quality Plan approval.

Superior quality control system shall be adopted to assure high product quality. Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of the equipment. All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all tests for the equipment shall be deemed to be included in bidder's scope.

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### 9. Inspection & Testing

1. The equipment shall be subject to inspection by BHEL/ OPTCL or authorized representative at bidder/manufacturers' works. Hence, Bidder shall furnish all necessary information concerning the supply to BHEL/ OPTCL.
2. The inspector shall have free access to the manufacturer's/ supplier's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality.
3. Bidder shall give at least 2 weeks' advance notice to BHEL/ Customer, regarding the date of testing to enable him or his representative to witness the tests. All the tests must be done as per the approved QAP.

### 10. Field Testing & Commissioning

1. Bidder shall carry out the installation, field testing and commissioning of the equipment. Further appropriate test and commissioning reports and as-built documentation as necessary be submitted.
2. Field testing and commissioning of the equipment shall be done by Bidder/OEM only.
3. Bidder shall also submit site acceptance testing (SAT) procedures and get them approved from BHEL/ OPTCL before carrying out the site testing at site.
4. Bidder/ OEM shall coordinate with manufacturers of other equipment wherever required and shall freely and readily supply all technical information for this purpose as and when called for.

### 11. Packing and Dispatch

1. Cables shall be despatched in non-returnable steel drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.
2. Cable accessories shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage. Packing of cable accessories shall be suitable for long storage (minimum 1 year).

### 12. List of Documents/ Drawings

Following drawing/ documents are attached for information purpose,

1. 400/220kV switchyard trench layout

### 13. Terms Used

The terms used in this specification can be referred as follows,

Employer/ Purchaser/ Owner refers to OPTCL/ BHEL

"Contractor/ Sub-contractor/Manufacturer/ Bidder" refers to successful bidder

"Equipment" refers to 38/66kV XLPE cable & accessories

**ANNEXURE- BOQ for 38/66kV XLPE cable & Accessories**

Sl. No.	Item Description	Long Description	Unit	Qty.
<b>A</b>	<b>Supply items</b>			
1	38/66kV XLPE, 1Cx240sqmm, Cu conductor cable	66kV XLPE, Cu conductor cable shall be complete in all respect and comprising of following but not limited to, 1. The cable construction shall as per applicable IEC & standard technical specification. 2. The exact length shall also be decided by bidder either after visiting site & making precise measurements at contract stage or on basis of layout drawings. Manufacturing lengths and drum length shall be determined with consultation & approval of BHEL/ OPTCL. <b>3. Bidder shall furnish calculations of cable for following during tendering stage only,</b> <b>(a) Screen/ sheath voltage under full load condition,</b> <b>(b) Screen/ sheath voltage during an external three phase symmetrical through-fault.</b> <b>4. Bidder shall furnish calculations for screen/ sheath voltage/ current and the recommended method for metallic screen bonding, i.e. single point/ cross bonding.</b> 5. Any other item/(s) required to complete the supply in all respect but not limited to above shall be in bidder's scope.	Meter	1500
2	66kV outdoor cable termination (heat shrinkable/ cold shrinkable type) kit compatible of 1Cx240sqmm copper cable suitable for tertiary weatherproof cable box of ICT/ transformer	66kV termination kit shall be complete in all respect and comprising of following but not limited to, 1. The cable end terminating kits shall be outdoor and dry type and suitable for the size of conductor, insulation and voltage/ current ratings of the cable. 2. The terminating kits shall be heat shrinkable/ cold shrinkable type for terminating at a weatherproof cable box of transformer. 3. Any other item/(s) such as weather shields/ sealing ends, lugs/ connector, hardware and other accessories required to complete the supply in all respect but not limited to above shall be in bidder's scope.	Set	12
3	1nox3 phase link box without SVL (sheath voltage limiter) at ICT/ transformer end	<b>1. Vendor shall furnish calculations for screen/ sheath voltage/ current and the recommended method for metallic screen bonding, i.e. single point bonding or cross bonding.</b> 2. Any other item/(s) such as mounting structure and other accessories required to complete the supply in all respect but not limited to above shall be in bidder's scope.	Set	2
4	1nox3 phase link box with SVL (sheath voltage limiter) at Station transformer end	<b>1. Vendor shall recommend the Voltage rating of Sheath Voltage Limiter (SVL).</b> <b>2. Vendor shall furnish calculations for screen/ sheath voltage/ current and the recommended method for metallic screen bonding, i.e. single point bonding or cross bonding.</b> 3. Any other item/(s) such as mounting structure and other accessories required to complete the supply in all respect but not limited to above shall be in bidder's scope.	Set	2
5	Metallic screen bonding/ earth continuity cable along with accessories	1. Any other item/(s) lugs/ connectors and other accessories required to complete the supply in all respect but not limited to above shall be in bidder's scope. (1lot=1 cable circuit) 2. This includes the complete earth continuity conductor, if required.	Meter	500
6	Single clamps, non-magnetic suitable/ compatible for 1Cx240sqmm, 66kV XLPE, copper cable	1. Single clamps shall be fixed at the distance of 1.5meters on both end of individual cable. 2. Any other item/(s) such as mounting/ fixing hardware and other accessories required to complete the supply in all respect but not limited to above shall be in bidder's scope.	No	1000
<b>B</b>	<b>Service Items</b>			
1	Supervision of installation of 38/66kV XLPE, 1Cx240sqmm, Cu conductor cable	Supervision of installation of 66kV XLPE, Cu conductor cable shall be completed in all respect and comprising of following but not limited to, 1. Supervision of laying of cables in single/ flat form as required on support structure using single clamps on cable trays/ racks of cable trench. 2. supervision of fixing of cable route marker, cable tag, phase marker etc. 3. Arrangement of special tools & tackles for smooth laying & installation 4. Any other supervisory service/(s) required to complete the work in all respect but not limited to above shall be in bidder's scope.	Meter	1500
2	Field testing & commissioning of 38/66kV XLPE, 1Cx240sqmm, Cu conductor cable	1. Field testing & commissioning of 66kV XLPE, Cu conductor cable along with accessories such end termination may be carried out in phase manner and hence simultaneous commissioning is not envisaged. 2. Field testing & commissioning shall be done as per approved SAT (site acceptance test), which shall be submitted by bidder and shall be approved by BHEL/ OPTCL. 3. Field testing & commissioning shall be carried out by skilled & experienced testing engineer. Test instruments along with valid calibration certificates for testing & commissioning shall be brought at site by bidder. 4. Any other service/(s) required to complete the testing & commissioning in all respect shall be in bidder's scope.	Meter	1500
3	Termination of 66kV outdoor cable termination (heat shrinkable/ cold shrinkable type) kit compatible of 1Cx240sqmm copper cable suitable for HT terminal of transformer	Termination of 66 kV outdoor cable termination (heat shrinkable/ cold shrinkable type) kit shall be completed in all respect and comprising of following but not limited to, 1. Termination of 66 kV outdoor cable termination (heat shrinkable/ cold shrinkable type) kit suitable/ compatible for copper cable for HT terminal of station transformer/ICT in all respect. 2. Fixing of structure for support of termination including other fixing arrangements. 3. Drilling of holes in non-magnetic plate of cable box for cable/ termination entry including plugging/ sealing of unused holes. All cable/ termination entry shall be from bottom only. 4. Termination of EHV cables shall be done by skilled and experienced jointer duly approved by Engineer-in charge. 5. Any other service/(s) required to complete the work in all respect but not limited to above shall be in bidder's scope.	No	12
4	Supervision of installation of 1nox3 phase link box without SVL (sheath voltage limiter) at ICT/ transformer end with installation of metallic screen bonding/ earthing cable along with accessories	Supervision of installation of 1nox3 phase link box without SVL (sheath voltage limiter) at ICT/ transformer end shall be completed in all respect and comprising of following but not limited to, 1. Supervision of installation of 1nox3 phase link box without SVL (sheath voltage limiter) at ICT/ transformer end along with installation of metallic screen bonding/ earthing cable along with accessories. 2. Any other supervisory service/(s) required to complete the work in all respect but not limited to above shall be in bidder's scope.	Set	2

Sl. No.	Item Description	Long Description	Unit	Qty.
5	Supervision of installation of 1nox3 phase link box with SVL (sheath voltage limiter) at Station transformer end along with installation of metallic screen bonding/ earthing cable along with accessories	Supervision of installation of 1nox3 phase link box with SVL (sheath voltage limiter) at station transformer end shall be completed in all respect and comprising of following but not limited to, 1. Supervision of installation of 1nox3 phase link box with SVL(sheath voltage limiter) at station transformer long with installation of metallic screen bonding/ earthing cable along with accessories. 2. Any other supervisory service/(s) required to complete the work in all respect but not limited to above shall be in bidder's scope.	Set	2

NOTES:

- 1 The overall quantity of contract may vary by ±20% of total contract value at contract stage. However, individual items quantity may vary upto any extent.



## Bharat Heavy Electricals Limited

Project: 400/220 kV GIS SUB STATION AT ERSAMA, PARADEEP, ODISHA

Technical Specification: 38/66kV XLPE Cable & accessories

Doc No. TB-420A-316-007C Rev 00

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EQUIPMENT SPECIFICATION UNDER SCOPE OF SUPPLIES/ SERVICE

1. CUSTOMER TECHNICAL SPECIFICATION

## SECTION: POWER AND CONTROL CABLE

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**Note:**

Kindly refer the technical requirements applicable for EHV Power Cables only. (Sl. no. 3 and other applicable clauses)

## SECTION: POWER & CONTROL CABLES

### 1. **POWER & CONTROL CABLES[ FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]**

#### CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

- 1.1.1. Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards, **supply to oil filtration units, DG supply to AC distribution board** and for supply for colony lighting from control room.
- 1.1.2. Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.
- 1.1.3. For all control/protection purposes, PVC insulated armoured control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.
- 1.1.4. POWERGRID has standardised the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables to be used per feeder in different application shall be as follows:

S.No.	From	To	Cable size	Cable type
1.	Main Switch Board	LT Transformer	2-1C X 630 mm <sup>2</sup> per phase 1-1C X 630 mm <sup>2</sup> for neutral	XLPE
2.	Main Switch Board	AC Distribution Board	2-3½C X 300 mm <sup>2</sup>	XLPE
3.	Main Switch Board	Oil Filtration Unit & <b>looping to other oil filtration units.</b>	1-3½C X 300 mm <sup>2</sup>	XLPE
4.	Main Switch Board	Colony Lighting	1-3½C X 300 mm <sup>2</sup>	XLPE

5.	Main Switch Board	HVV pump LCP	1-3½C X 300 mm <sup>2</sup>	XLPE
6.	Main Switch Board	Main Lighting distribution board	1-3½C X 300 mm <sup>2</sup>	XLPE
7.	AC Distribution Board	D.G. Set AMF Panel	2-3½C X 300 mm <sup>2</sup>	XLPE
8.	AC Distribution Board	Emergency Lighting distribution board	1-3½C X 70 mm <sup>2</sup>	PVC
9.	AC Distribution Board	ICT MB	1-3½C X 70 mm <sup>2</sup>	PVC
10.	AC Distribution Board	Bay MB	1-3½C X 70 mm <sup>2</sup>	PVC
11.	Bay MB	AC Kiosk	1- 3 ½ x 35 mm <sup>2</sup>	PVC
12.	AC Distribution Board	Battery Charger	1-3½C X 70 mm <sup>2</sup>	PVC
13.	DCDB	Battery	2-1C X 150 mm <sup>2</sup>	PVC
14.	DCDB	Battery Charger	2-1C X 150 mm <sup>2</sup>	PVC
15.	DCDB	Protection/PLCC panel	1-4C X 16 mm <sup>2</sup>	PVC
16.	Main Lighting DB	Lighting panels(Indoor)	1-3½C X 35 mm <sup>2</sup>	PVC
17.	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm <sup>2</sup>	PVC
18.	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm <sup>2</sup>	PVC
19.	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm <sup>2</sup>	PVC
20.	Lighting Panel	Sub lighting panels	1-4C X 16 mm <sup>2</sup>	PVC
21.	Lighting Panel	Street Lighting Poles	1-4C X 16 mm <sup>2</sup>	PVC
22.	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	1-2C X 6 mm <sup>2</sup>	PVC
23.	Bay MB	Equipments	1-4C X 16 mm <sup>2</sup> /1-4C X 6 mm <sup>2</sup> /1-2C X 6 mm <sup>2</sup>	PVC

- 1.1.5 Bidder may offer sizes other than the sizes specified in clause 1.1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current ( ***including future bays/load requirement***), voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser's approval. **The entire power and control cables & special cables (if any) required shall be executed by contractor for completion of present scope of work.**
- 1.1.6 Cables shall be laid conforming to IS : 1255.
- 1.1.7 While preparing cable schedules for control/protection purpose, following shall be ensured:
- 1.1.7.1 Separate cables shall be used for AC & DC.
- 1.1.7.2 Separate cables shall be used for DC1 & DC2.
- 1.1.8 For different cores of CT & CVT separate cable shall be used
- 1.1.9 At least one (1) cores shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.
- 1.1.10 For control cabling, including CT/VT circuits, 2.5 sq.mm. size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration, additional cores shall be used. Further for potential circuits of energy meters, separate connections by 2 cores of 2.5 sq.mm. size shall be provided.
- 1.1.11 Standard technical data sheets for cable sizes up to and including 1100V are enclosed at Annexure. Cable sizes shall be offered/manufactured in accordance with parameters specified in standard technical data sheets. Technical data sheet for any other cores/sizes required during detailed engineering shall be separately offered for owner's approval by the contractor/supplier. ***Submission of standard technical data sheets for these cable sizes are not required for approval. Contractor/supplier shall intimate name of proposed approved cable manufacturer along with cable sizes, its quantity required during detailed engineering for purchaser's information and acceptance.***

## 1.2. TECHNICAL REQUIREMENTS

### 1.2.1. General

- 1.2.1.1. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 1.2.1.2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3 phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases at rated conductor temperature (70 degC for PVC insulated cables and 90 degC for XLPE insulated cables). The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.
- 1.2.1.3. The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.
- 1.2.1.4. The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.
- 1.2.1.5. The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.
- 1.2.1.6. Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.
- 1.2.1.7. Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS : 1554 (Part 1) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.
- 1.2.1.8. The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.
- 1.2.1.9. All the cables shall pass fire resistance test as per IS:1554 (Part-I)

- 1.2.1.10. The normal current rating of all PVC insulated cables shall be as per IS:3961.
- 1.2.1.11. Repaired cables shall not be accepted.
- 1.2.1.12. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.
- 1.2.2. **XLPE Power Cables**
- 1.2.2.1. The XLPE (90°C) insulated cables shall be of FR type, C1 category conforming to IS:7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. **All cables shall be of armoured type.** For single core cables, the **armouring** shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables.
- 1.2.3. **PVC Power Cables**
- 1.2.3.1. The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. **All cables shall be of armoured type.** For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.
- 1.2.4. **PVC Control Cables**
- 1.2.4.1. The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables. **All cables shall be of armoured type.** The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour.
- 1.2.4.2. Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of

cores shall be done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS 1554 (Part-1).

## **2. HV POWER CABLES[ FOR WORKING VOLTAGES FROM 3.3 kV AND INCLUDING 33 kV]**

### **2.1. HV POWER CABLE FOR AUXILIARY POWER SUPPLY**

(a) The HV cable of 1Cx185 mm<sup>2</sup> (Aluminium Conductor) or 1Cx120mm<sup>2</sup> (Copper Conductor) of voltage class as specified for 630 kVA **and 800 kVA** LT transformer for interconnecting 630kVA **and 800 kVA** LT transformer to the SEB feeder shall be, XLPE insulated, armoured cable conforming to IS 7098 (Part-II) or IEC 60502-2 1998. Terminating accessories shall conform to IS 17573-1992 or IEC 61442-1997/IEC60502-4 1998.

(b) The HV cable of 3Cx95 mm<sup>2</sup> (Aluminium Conductor) or 3Cx70mm<sup>2</sup> (Copper Conductor) of voltage class as specified for 250kVA LT transformer for interconnecting 250kVA LT transformer to the SEB feeder shall be, XLPE insulated, armoured cable conforming to IS 7098 (Part-II) or IEC 60502-2 1998. Terminating accessories shall conform to IS 17573-1992 or IEC 61442-1997/IEC60502-4 1998.

2.2. Only overhead connection has been foreseen for interconnecting **630 kVA and 800 kVA**, LT transformer to the tertiary of the ICT. However, HV cable connections in place of overhead connection, if necessary shall also be in the scope of contractor. In this case contractor shall provide 1C x 185 mm<sup>2</sup> (Aluminium Conductor) or 1Cx120mm<sup>2</sup> (Copper Conductor), 38/66kV HV cable along with necessary terminating accessories. The construction of XLPE insulated, armoured HV cable shall be generally conforming to IS 7098 (Part-III). Terminating accessories shall conform to IEC60840 1999.

2.3. Bidder may offer sizes other than the sizes specified in clause 2.1 and 2.2. In such case sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser's approval.

### **2.4. Constructional Requirements**

Cable shall have compacted circular Aluminium conductor, Conductor screened with extruded semi conducting compound , XLPE insulated, insulation screened with extruded semi conducting compound, **distinct extruded PVC inner sheath ( Type ST-2) with FR properties**, armoured

with non-magnetic material **for single core cables and galvanized steel wire/strip for multicore cables** , followed by extruded PVC outer sheath(Type ST-2), with FR properties . **The armour shall be capable of withstanding rated short time current of conductor.**

- 2.5 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.
- 2.6 The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.
- 2.7 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

### **3. EHV XLPE POWER CABLE [FOR WORKING VOLTAGES FROM 66 kV UP TO AND INCLUDING 500 kV]**

#### **3.1 TECHNICAL REQUIREMENTS**

The XLPE insulated, EHV cable shall conform to the requirements of IEC 60502-2 (applicable clauses only) for construction and IEC 60840/ IEC62067 ( as applicable) for testing. The terminating accessories shall conform to IEC 60840 / IEC62067 ( as applicable).

- 3.2 The cable shall be of specified EHV grade, single core, unarmoured, stranded compacted Copper conductor, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, cross linked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non woven tape with water swellable absorbent over insulation screen, followed by radial sealing (Metal sheath of Lead alloy 'E'), metallic screening by concentric layer of plain copper wire followed by an open helix of copper & overall **HDPE** sheathed & graphite coated and conforming to the technical particulars of specification.

- 3.3 The construction of cable shall generally conform to the description mentioned in above mentioned clause of the specification. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable. The bidder shall enclose with the bid, drawing showing cross section of the cable. The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids.

- 3.4 The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids.
- 3.5 They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.
- 3.6 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.
- 3.7 The cables shall have outer sheath of a **HDPE** material.
- 3.8 Repaired cables shall not be accepted.
- 3.9 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

#### **4 CABLE DRUMS**

- 4.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum. ***Drums offered shall conform to relevant standards. Drum drawings are not required to be submitted for approval.***
- 4.2 Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. Maximum, One (1) number non standard length of cable size(s) may be supplied in drums for completion of project.
- 4.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 4.4 A clear space of at least 40 mm shall be left between the cables and the lagging.
- 4.5 Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

- 4.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

## 5 TYPE TESTS

- 5.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

### 5.2 ***XLPE INSULATED POWER CABLES ( For working voltages up to and including 1100V ):-***

- 5.2.1 Following type tests ( on one size in a contract) as per IS: 7098 (Part 1) – 1988 including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:

- a) Physical tests for insulation
  - i) Hot set test
  - ii) Shrinkage test
- b) Physical tests for outer sheath
  - i) Shrinkage test
  - ii) Hot deformation
  - iii) Heat shock test
  - iv) Thermal stability

- 5.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, ~~Section: GTR for the following tests~~

- a) Water absorption (gravimetric) test.
- b) Ageing in air oven
- c) Loss of mass in air oven
- d) Short time current test on power cables of sizes 240 sqmm and above on
  - i) Conductors.
  - ii) Armours.
- e) Test for armouring wires/strips.
- f) Oxygen and Temperature Index test.
- g) Flammability test.

### 5.3 ***PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-***

5.3.1 Following type tests ( on one size in a contract) as per IS: 1554 (Part 1) - 1988 including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V:

- a) Physical tests for insulation and outer sheath
  - i) Shrinkage test
  - ii) Hot deformation
  - iii) Heat shock test
  - iv) Thermal stability
- b) High voltage test (water immersion test only a.c. test as per clause no. 16.3.1).

5.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following-

- a) High voltage test (water immersion d.c. test as per clause no. 16.3.2 of IS: 1554 (Part 1) - 1988).
- b) Ageing in air oven.
- c) Loss of mass in air oven.
- d) Short time current test on power cables of sizes 240 sqmm and above on
  - i) Conductors.
  - ii) Armours.
- e) Test for armouring wires/strips.
- f) Oxygen and Temperature Index test.
- g) Flammability test.

5.4 ***XLPE INSULATED HV POWER CABLES( For working voltages from 3.3 kV and including 33 kV)-***

5.4.1 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for XLPE insulated HV power cables (as per IS 7098 Part-II including its amendment or as per IEC).

5.5 ***XLPE INSULATED EHV POWER CABLES ( For working voltages from 66kV up to and including 500 kV)-***

5.5.1 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for XLPE insulated EHV cables ( as per IEC60840 for cables up to 150 kV & IEC 62067 for cables above 150 kV).

**5.6            *TERMINATING & JOINTING ACCESSORIES-***

5.6.1           Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for Terminating/jointing accessories as per IS 17573:1992/ IEC 60840:1999/ IEC62067.

<b>PROJECT: 2X500 MVA, 400/220 KV GIS S/S AT ERSAMA &amp; ASSOCIATED 2 NOS 400 KV BAY EXTN AT DUBURI</b>
<b>CUSTOMER: ODISHA POWER TRANSMISSION CORPORATION LIMITED (OPTCL)</b>
<b>Technical Specification: TB-4-420A-316-016 Rev 00</b>
<b>Section-3: Project Details and General Specification</b>

## SECTION- 3

### PROJECT DETAILS AND GENERAL SPECIFICATIONS

#### 3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

#### 3.1 PROJECT DETAILS

	<b>Particular</b>	<b>Details</b>
a)	Customer	ODISHA POWER TRANSMISSION CORPORATION LIMITED (OPTCL)
b)	Engineer/Consultant/ Inspector	-
c)	Project Title	2X500 MVA, 400/220 KV GIS S/S AT ERSAMA & ASSOCIATED 2 NOS 400 KV BAY EXTN AT DUBURI
d)	Project Location	<b><u>400/220kV GIS S/S</u></b> Place: Erasama, Paradeep District: Jagatsingha State: Odisha <b><u>400kV AIS S/S Bay Extn.</u></b> Place: Duburi District: Jajapur State: Odisha
e)	Latitude & Longitude	<b><u>400/220kV GIS S/S</u></b> North: 20°12'32" and East: 86°21'44" <b><u>400kV AIS S/S Bay Extn.</u></b> North: 20°56'14" and East: 86°00'23"
f)	Nearest Railway Station	Erasama – At a distance of about 32 km from Paradeep station Duburi – At a distance of about 14 km from Jajpur Road station
g)	Distance of project location from the Railway station	Erasama – At a distance of about 32 km from Paradeep station Duburi – At a distance of about 14 km from Jajpur Road station
h)	Nearest Major Town	Bhubaneswar
i)	Distance of the town from the project site	86 Km from Erasama & 120 Km from Duburi
j)	Nearest commercial airport	Biju Patnaik International Airport, Bhubaneswar

<b>PROJECT: 2X500 MVA, 400/220 KV GIS S/S AT ERSAMA &amp; ASSOCIATED 2 NOS 400 KV BAY EXTN AT DUBURI</b>
<b>CUSTOMER: ODISHA POWER TRANSMISSION CORPORATION LIMITED (OPTCL)</b>
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<b>k)</b>	Distance of airport from the project site	86 Km from Erasama & 120 Km from Duburi
	<b>SITE CONDITIONS</b> (for design purposes)	
<b>a)</b>	Annual mean if maximum monthly average temperature	50°C
<b>b)</b>	Annual mean if minimum monthly temperature	5°C
<b>c)</b>	Design ambient temperature	50°C
<b>d)</b>	Average Rainfall in mm	1500 mm
<b>e)</b>	Average thunderstorm days per year	77 days
<b>f)</b>	Maximum Relative humidity	100 %
<b>g)</b>	Average Relative humidity	85 %
<b>h)</b>	Height above mean sea level	Less than 1000 meters
<b>i)</b>	Pollution Severity	Heavily polluted
<b>j)</b>	Criteria for Wind Resistant design of structures and equipment	Standard Applicable - IS 875 (Part 3)
<b>k)</b>	Basic Wind speed "Vb" at ten meters above the mean ground level.	55m/ sec for Erasama 50 m/ sec for Duburi
<b>l)</b>	Risk Coefficient "K1"	1
<b>m)</b>	Seismic Co-efficient	0.06g Horizontal 0.01g Vertical

### 3.1.1 SYSTEM PARAMETERS

Sl.No.	Parameters	400 kV	220 kV	33 kV
1	Highest system voltage	420 kV rms	245 kVrms	36
2	System Frequency	50 Hz		
3	Variation in Frequency	+ - 2.5 %		
5	Lightning Impulse voltage	±1425kVp	± 1050kVp	170
6	Switching impulse voltage	±1050kVp	-	
7	Power frequency withstand for 1 min (rms)	630 kV (rms)	460 kV (rms)	70 kV (rms)
8	Max. fault level (3/1 sec.)	63 kA	50kA	31.5kA
9	Minimum creepage distance	13020 mm (Erasama) 10500 mm (Duburi)	7595mm (Erasama) -	1116mm (Erasama) 900mm (Duburi)
10	System Neutral Earthing	Effectively Earthed		
11	Corona Extinction Voltage	320kV	156kV	-
12	Radio Interference Voltage	500µV at 266kV	500µV at 167kV	-

### 3.1.2 AUXILIARY POWER

Nominal Voltage V	Variation	Frequency Hz or DC	Phase	Wires	Neutral Connection
430	+10%	50±5%	3	4	Solidly earthed
240	+10%	50±5%	1	2	Solidly earthed
220	187V - 242V	DC	DC	2	Isolated 2 wires
50	45V - 55V	DC	DC	2	+ve earthed

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**3.1.3** The minimum electrical clearances for 400/220/33kV switchyard shall be as given below:

	<b>400kV</b>	<b>220kV</b>	<b>33kV</b>
Phase to earth clearance	3400 mm	2160mm	320mm
Phase to phase clearance	3900 mm	2160mm	320mm
Section clearance	6500 mm	5000mm	3000mm
Ground Clearance	8000 mm	5500mm	4000mm

**3.2 INSTRUCTION TO BIDDERS:**

The bidders shall furnish technical data sheets, catalogues, engineering data, technical information, design documents, drawings etc. fully in conformity with the technical specification.

The supplier should be approved by Employer (OPTCL). If not, it is the responsibility of the vendor to be assessed and approved by Employer, before placement of order by BHEL. Any cost involved in vendor assessment/approval must be borne by the vendor himself.

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Purchaser. Sufficient amount of information for justifying such proposals shall be furnished to Purchaser along with the bid to enable the Purchaser to determine the acceptability of these proposals.

Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood to be indicative of the function and quality desired and not restrictive. Other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

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### **3.3 CODES AND STANDARDS**

In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed.

Except where otherwise specified or implied, the bidder shall comply with the latest edition of the relevant Indian Standards, International Electrotechnical Commission (IEC) standards and any other standards mentioned in this Specification. The Bidder may submit for approval, equipment or materials conforming to technically equivalent National Standards. In such cases copies of the relevant Standards or part thereof, in the English language shall be submitted with the Tender.

In case of conflict the order of precedence shall be (1) IEC, (2) IS and (3) other alternative standard.

Reference to a particular standard or recommendation in this Specification does not relieve the Bidder of the necessity of providing the Contract Works complying with other relevant standards or recommendations.

The list of standards provided in the schedules of this Specification is not to be considered exhaustive and the Bidder shall ensure that equipment supplied under this contract meets the requirements of the relevant standard whether or not it is mentioned therein.

Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

### **3.4 LANGUAGE AND SYSTEM OF UNITS**

The English language shall be used in all written communications between the Employer, the BHEL/OPTCL and the Bidder with respect to the services to be rendered and with respect to all documents and drawings procured or prepared by the Bidder pertaining to the work, unless otherwise agreed by the Employer.

It is required that danger plates, equipment designation labels or plates, instruction notices on plant and general substation notices be written in English, Hindi and Oriya. Control switch and lamp labels, indicator lamp and annunciator inscriptions shall be in English only.

The Bidder must furnish a schedule giving the English, Hindi and Oriya version of all labels, notices, etc., for approval.

The design features of all equipment shall be based on the SI system of units.

### **3.5 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.

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All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow (not applicable for this project), short circuit etc for the equipment.

### **3.6 CORRESPONDENCE, DRAWINGS, APPROVAL PROCEDURE AND SAMPLES**

#### **3.6.1 Drawings & Document Submission**

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the bidder (including those of sub-vendors) shall bear project specific title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

All dimensions marked on drawings shall be considered correct although measurement by scale may differ from general arrangement drawings. Detailed drawings shall be worked to where they differ from general arrangement drawings.

All drawings for approval shall have the OPTCL-LOGO and the name of the Employer.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

The review of these document/data/drawings by the purchaser will cover only general conformance of the document/data/drawings to the specification and contract, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect plan layout. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. The review and/or approval by the purchaser shall not be considered by the bidder, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing, fabrication and execution of work in connection with the equipment/system prior to the approval of the drawings shall be at the bidder's risk. The bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Purchaser. However, if some changes are necessitated in the design of the equipment/system at a later date, the bidder may do so, but such changes shall promptly be brought to the notice of the Purchaser indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification. Approval of bidder's drawing or work by the Purchaser shall not relieve the bidder of any of his responsibilities and liabilities under the Contract.

#### **3.6.2 Bidder's Drawing Submission and Approval Procedure**

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The following procedure for submission and review/approval of the drawings, data reports, information, etc. shall be followed by the bidder:

- a. All data/information furnished by Vendor in the form of drawings, documents, Catalogues or in any other form for Employer's information/interface and/or review and approval are referred by the general term "drawings".
- b. The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be furnished by the bidder. This list shall be updated if required at suitable interval during detailed engineering.
- c. All drawings (including those of sub-vendor) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The bidder shall furnish this format to his sub-vendor along with his purchase order for sub-vendor's compliance.
- d. Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. Employer shall forward their comments within four (4) weeks of receipt of drawings.
- e. The OPTCL/BHEL reserves the right to request any additional information that may be considered necessary in order to fully review the drawings. Drawings for approval shall be submitted as paper prints and shall bear the approved contract references.
- f. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	Approved
CATEGORY II	Approved, subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

- g. Bidder shall resubmit the drawings approved under Category II, III within one (1) week of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.).
- h. In case Bidder does not agree with any specific comment, he shall furnish the explanation for the same to Employer for consideration. In all such cases Bidder shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- i. It is the responsibility of the Bidder to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- j. Bidder shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Bidder shall resubmit the drawings identifying the changes (along with reasons for changes) for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

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### 3.6.3 As Built Drawings

After completion of work on site all drawings shall be revised where necessary to show the equipment as installed and three copies submitted duly signed by site-in-charge. Following approval, two reproducible transparencies and twenty prints shall then be provided as required by the OPTCL/BHEL and shall be of sufficient detail to enable all parts to be identified. The bidder shall also submit, where possible, digitally stored copies of all as-built drawings on disc or CD-ROM in a format compatible with the Employer's drawing system.

Approval of drawings will not in any way relieve the Bidder of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

### 3.6.4 Operation and Maintenance Manual

- a. The Bidder shall submit to the Employer preliminary instruction manuals for all the equipment for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least sixty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipment, the transportation, storage, installation, testing, commissioning, operation and maintenance procedures, etc. separately for each component/equipment along with log record format. After approval by the Engg. In charge the Bidder shall deliver ten (10) copies of the complete manual.
- b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted.
- c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.
- d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together will all relevant pamphlets.
- e. The manuals shall include the following
  - a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.
  - b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals) have been supplied to the Employer.

### 3.6.5 Final Submission of drawings and documents

The Bidder shall furnish the following after approval of all drawings /documents and test reports:

- a. List of drawings bearing the Employer's and Bidder's drawing number.

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- b. Six (6) bound sets along-with two (2) sets of CD-ROMs/ DVD/Portable hard disk of all final drawings/documents.
- c. Bidder shall also furnish six (6) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Bidder shall also furnish two (2) sets of CD-ROMs/ DVD/Portable hard disk of all as-built drawings as decided by the Employer.
- d. The Bidder shall also furnish four (4) copies and two (2) sets of CD-ROMs/ DVD/Portable hard disk of instruction/ operations & maintenance manuals (after approval) for all the equipment.

### **3.6.6 Test Reports**

Two (2) copies of all test reports shall be supplied for approval before shipment of Equipment. The report shall indicate clearly the standard value specified for each test to facilitate checking of the reports. After final approval six (6) bound copies and two (2) sets of CD-ROMs/ DVD/Portable hard disk of all type and routine test reports shall be submitted to Employer.

### **3.7 MATERIAL /WORKMANSHIP**

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the bidder shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Bidder.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

### **3.8 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE**

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Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

### **3.8.1 Space Heaters**

Space heaters where provided shall be suitable for continuous operation at 240V supply voltage. On-off switch and fuse shall be provided.

One or more adequately rated permanently or thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimise deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature at approximately 10C, above the outside air temperature to prevent condensation. This shall be demonstrated by tests.

### **3.8.2 Fungi Static Varnish**

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### **3.8.3 Ventilation Openings**

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

## **3.9 CLEANING, PAINTING AND TROPICALASATION**

### **3.9.2 General**

All paints shall be applied in strict accordance with the paint manufacturer's instructions.

All painting shall be carried out on dry and clean surfaces and under suitable atmospheric and other conditions in accordance with the paint manufacturer's recommendations.

An alternative method of coating equipment such as with epoxy resin-based coating powders will be permitted, subject to the approval of the Engg. In charge (Divisional Engr.), and such powders shall comply with the requirements of IEC 455. The Bidder shall provide full details of the coating process to the Engg. In charge (Divisional Engr.) for approval.

It is the responsibility of the Bidder to ensure that the quality of paints used shall withstand the tropical heat and extremes of weather conditions specified in the schedules. The paint shall not peel off, wrinkle, be removed by wind, storm and handling on site and the surface finish shall neither rust nor fade during the service life of the equipment.

The colors of paints for external and internal surfaces shall be in accordance with the approved color schemes.

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### 3.9.3 Works Painting Process

All steelworks, plant supporting steelworks and metalwork, except galvanised surfaces or where otherwise specified, shall be shot blasted to BS 7079 or the equivalent ISO standard. All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS 6005 "Code of Practice for phosphating iron and sheet steel". All surfaces shall then be painted with one coat of epoxy zinc rich primer, two pack type, to a film thickness of 50 microns. This primer shall be applied preferably by airless spray and within twenty minutes but not exceeding one hour of shot blasting.

All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth surface.

The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance with BS 7079 or the equivalent ISO, and painted within a period of preferably twenty minutes, but not exceeding one hour with an oil resisting coating of a type and make to the approval of the BHEL/OPTCL.

The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming as required above, shall be painted with one coat zinc chromate primer, one coat phenolic based undercoating, followed by one coat phenolic based finishing paint to a light or white colour. For equipment for outdoor use this shall be followed by a final coat of anti-condensation paint of a type and make to the approval of the BHEL/OPTCL, to a light or white colour. A minimum overall paint film thickness of 150 microns shall be maintained throughout.

All steelworks and metalwork, except where otherwise specified, after preparation and priming as required above shall be painted with one coat metallic zinc primer and two coats of micaceous iron oxide paint followed by two coats of either phenolic based or enamel hard gloss finished coloured paint to the approval to an overall minimum paint film thickness of 150 microns.

Galvanised surfaces shall not be painted in the works.

All nuts, bolts, washers etc., which may be fitted after fabrication of the plant shall be painted as described above after fabrication.

The painted metal works shall be subjected to paint qualification test as per draft ANSI/IEEE-Std 37.21 - 1985 clause 5.2.5.

### 3.9.4 Colour Schemes

The Bidder shall propose a colour scheme for the sub-station for the approval of BHEL/OPTCL. The decision of BHEL/OPTCL shall be final. The scheme shall include:

- Finishing colour of indoor equipment
- Finishing colour of outdoor equipment
- Finish colour of all cubicles
- Finishing colour of various auxiliary system equipment including piping.
- Finishing colour of various building items.

All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all Employer's electrical equipment in Employer's switchyard are painted with shade 631 of IS: 5 and Employer will prefer to follow the same for this project also. All indoor cubicles shall be of same colour scheme and for other miscellaneous items colour scheme will be subject to the approval of the BHEL/OPTCL.

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Sl. No.	Equipment	Application Environment			
		Indoor		Outdoor	
		Colour	Code IS:5	Colour	Code IS:5
<b>400kV/220kV/132kV Class Equipment</b>					
1	Transformers	—	—	Light grey	631
2	Marshalling boxes, CTs, PT's, CVT's, surge counter casings, junction boxes etc.	Light Admiralty grey.	697	Light Admiralty grey.	697
3	Control and relay panels, PLCC cabinets etc.	Smoke grey	692	—	—
4	Porcelain parts i.e. insulators	Dark brown	412	Dark brown	412
5	All structures/ metallic parts exposed to atmosphere	Hot dip galvanised			
<b>33kV Class equipment</b>					
6	Switchgear cubicles	Smoke grey	692	Light grey	631
7	Control and relay panels LT switchgear	Smoke grey	692	—	—
8	LT switchgear exterior	Smoke grey	692	Light grey	631
9	ACDB/ MCC	Smoke grey	692	Light grey	631
10	DCDB	Smoke grey	692	—	—
11	LT bus duct in side enclosure	Matt Paint		—	—
12	LT bus duct outside enclosure	Smoke grey	692	—	—
13	Motors	Smoke grey	692	Light grey	631
14	Diesel generator engine	Smoke grey	692	—	—
15	Diesel generator	Smoke grey	692	—	—
16	LT transformers	Smoke grey	692	Light grey	631
17	Battery charger	Smoke grey	692	—	—
18	Mimic diagram 400kV 220kV 132kV 33kV 11kV 415V	Dark violet Golden yellow Sky blue Signal red Canary yellow Middle brown	796 356 101 537 309 411	— — — — — —	— — — — — —
	Miscellaneous				
19	Control modules and console inserts	Smoke grey	692	Light grey	631
20	Lighting package equipment outside	Light grey	631	Light grey	631
21	Lighting package equipment inside	Glossy white		Glossy white	
22	Water pipes	sea green	217	sea green	217
23	Air pipes	Sky blue	101	Sky blue	101
24	Transformer oil pipes	Light brown	410	Light brown	410
25	Fire Installations	Fire red	536	Fire red	536
26	Insulating oil/ gas treatment plant	Gulf red	473	Gulf red	473

**Table 10.3.4. Recommended color schemes**

### 3.10 DEGREES OF PROTECTION

Degrees of protection shall be provided in accordance with IEC 144 and IEC 529 and be as follows:

- For outdoor applications, IP 55.
- For indoor applications where purpose built accommodation is provided, e.g. switch and control and relay rooms in auxiliary plant buildings, IP 41.
- Where dust can adversely affect equipment within the enclosure, this equipment should be separately housed with a degree of protection of IP 51.

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- For indoor applications where the equipment is housed in the same building as that enclosing water and steam operated equipment, the degrees of protection stated in the previous paragraph shall be up-rated to IP 44 and IP 54 respectively.

Where more severe environments exist, e.g. steam and oil vapour or other deleterious chemical environments, special measures will be necessary and the degree of protection required will be specified separately.

The Bidder shall submit a schedule for providing the degree protection to various control boxes, junction boxes etc. for the BHEL/OPTCL's approval.

### **3.11 RATING PLATES, NAME PLATES AND LABELS**

- a) All apparatus shall be clearly labelled indicating, where necessary, its purpose and service positions. Each phase of alternating current and each pole of direct current equipment and connections shall be coloured in an approved manner to distinguish phase or polarity.
- b) The material of all labels and the dimensions, legend, and method of printing shall be to approval. The surface of indoor labels shall have a matt or satin finish to avoid dazzle from reflected light.
- c) Colours shall be permanent and free from fading. Labels mounted on black surfaces shall have white lettering. „Danger“ plates shall have red lettering on a white background.
- d) All labels and plates for outdoor use shall be of non-corroding material. Where the use of enamelled iron plates is approved, the whole surface including the back and edges, shall be properly covered and resistant to corrosion. Protective washers of suitable material shall be provided front and back on the securing screws.
- e) Labels shall be engraved in Hindi, English and Oriya. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards.
- f) Any other relevant information which may be required for groups of smaller items for which this is not possible e.g. switch bays etc. a common name plate in Oriya with the title and special instructions on it shall be provided.
- g) No scratching, corrections or changes will be allowed on name plates.
- h) All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved.
- i) On the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit/ feeder/ cubicle box designation.
- j) All front mounted equipment shall be also provided, at the rear, with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The name plates shall be mounted directly by the side of the respective equipment wiring.
- k) Name plates of cubicles and panels may be made of non rusting metal or 3 ply lamicaid. These name plates may be black with white engraved lettering.

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- l) The name plate inscription and size of name plates and letters shall be submitted to the BHEL/OPTCL/ Engineer for approval.
- m) The nameplates of the apparatus shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:
  - Concise descriptive title of the equipment
  - Rating and circuit diagrams
  - Manufacturer's name, trade-mark, model type, serial number
  - Instruction book number
  - Year of manufacture
  - Total weight (for capacitor racks indicate weight, for capacitors indicate quantity of liquid)
  - Special instructions, if any, about storage, transportation, handling etc.
- n) Each measuring instrument and meter shall be prominently marked with the quantity measured e.g. kV, A, MW etc. All relays and other devices shall be clearly marked with manufacturers name, manufacturer's type, serial number and electrical rating data.
- o) Danger plates and plates for phase colours shall be provided as per requirement. The Bidder shall devise a system to designate equipment and sub-systems. The nameplates/labels displaying these designations shall be installed at appropriate locations. Whenever motion or flow of fluids is involved, plates showing direction of motion or flow shall also be provided.

### 3.12 BOLTS AND NUTS

All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate national standards for metric threads, or the technical equivalent.

Except for small wiring, current carrying terminal bolts or studs, for mechanical reasons, shall not be less than 6 mm in diameter.

All nuts and pins shall be adequately locked. Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanising or electro galvanising to service condition 4. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Where bolts are used on external horizontal surfaces where water can collect, methods of preventing the ingress of moisture to the threads shall be provided.

Each bolt or stud shall project at least one thread but not more than three threads through its nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members. Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back on the securing screws.

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### 3.13 GALVANISING:

#### 3.13.1 General

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out.

#### 3.13.2 Galvanising

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot dip galvanised. High tensile steel nuts, bolts and spring washers shall be electro galvanised to service condition 4. All steel conductors including those used for earthing and grounding (above ground level) shall also be galvanised according to IS 2629.

All galvanising shall be applied by the hot dip process and shall comply with IS 2629, IS 2633, IS 4759, IS 1367 or IS 6745.

All welds shall be de-scaled, all machining carried out and all parts shall be adequately cleaned prior to galvanising. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specially approved by the BHEL/OPTCL. All nuts shall be galvanised with the exception of the threads which shall be oiled. Surfaces which are in contact with oil shall not be galvanised or cadmium plated.

Partial immersion of the work will not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

Galvanising of wires shall be applied by the hot dip process and shall meet the requirements of IS 2141.

The minimum weight of the zinc coating and minimum thickness of coating for outdoor equipment shall be as follows:

a) For sections & plates above 5mm of thickness	910 gm/sq.m	127 microns
b) For sections & plates below 5mm of thickness	610 gm/sq.m	87 microns
c) For surfaces embedded in concrete	800 gm/sq.m.	

The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects such as discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to six one minute dips in copper sulphate solution as per IS 2633.

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Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanising tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

### **3.14 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS**

The terminal connectors shall conform strictly to the requirements if the latest versions of following standards as amended up-to-date, except otherwise,

- |      |          |   |
|------|----------|---|
| i)   | IS: 5561 | Power Connectors  |
| ii)  | IS: 617  | Aluminium & Aluminium Alloy                                     |
| iii) | IS: 2629 | Recommended Practice for HDG of iron & steel                    |
| iv)  | IS: 2633 | Method of testing uniformity of coating of zinc coated articles |

The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS: 617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 4mm thick bimetallic liner.

The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last at least till erection time.

### **3.15 CABLE GLANDS AND LUGS/FERRULES**

Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.



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When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and "DANGER" notices shall be affixed to the outsides of junction boxes or marshalling kiosk. Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

### 3.16.2 LV power cabling

**LVAC** cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the Bidder. The Bidder shall be responsible for drilling the cable gland plate.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

## 3.17 PRODUCTION PROCESS REQUIREMENTS

### 3.17.1 CASTINGS

#### GENERAL

All castings shall be true to pattern, free from defects and of uniform quality and condition. The surfaces of castings which do not undergo machining, shall be free from foundry irregularities. The castings shall be subject to NDT, chemical, mechanical and metallographic tests. Details of the same shall be furnished to BHEL/OPTCL for review/approval. Magnetic particle inspection (MPI) test, wherever applicable, shall be carried out in longitudinal and transverse direction to detect radial and axial cracks.

#### IRON CASTINGS

Iron casting material shall be in accordance with ASTM A 126 Class B. A copy of the ladle analysis shall be sent to the BHEL/OPTCL. Each casting shall have a test bar from which tension test specimens may be taken. Test specimen shall be in accordance with ASTM A 370 and tested in accordance with ASTM E8. The Bidder shall submit his procedures for testing and acceptance for iron castings for approval by the BHEL/OPTCL.

#### STEEL CASTINGS

Steel castings shall be manufactured in accordance with ASTM A 27 and shall be subjected to appropriate tests and inspection as detailed herein.

Copies of mandatory documentation, such as ladle analyses and mechanical test results, shall be sent to the BHEL/OPTCL. (Non-ferrous casting material and castings shall be manufactured in accordance with the appropriate ASTM standards for the material concerned).

### 3.17.2 FORGINGS

When requested by the BHEL/OPTCL, forgings will be subjected to inspection in the regions of fillets and changes of section by suitable method. Magnetic particle, dye-penetration, radiographic or ultrasonic, or any combination of these methods may be used to suit material type and forging design.

The testing is to be carried out after the rough machining operation and is to be conducted according to the appropriate ASTM standards.

MPI test on forging shall be carried out to detect both radial and axial cracks. Ferrous forgings shall be demagnetised after such tests.

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Any indentations which prove to penetrate deeper than 2.5% of the finished thickness of the forging shall be reported to the BHEL/OPTCL giving location, length, width and depth. Any indentations which will not machine out during final machining shall be gouged out and repaired using an approved repair procedure. Repair of rotating elements by welding will only be accepted subject to detailed examination of the proposal by the BHEL/OPTCL prior to the repair being carried out. The forging shall be tested for mechanical and metallographic tests as per ASTM. The details shall be mutually discussed/agreed upon.

### **3.17.3 FABRICATED COMPONENTS**

All components machined or fabricated from plate, sheet or bar stock shall meet the material requirements of ASTM or material specification approved by the BHEL/OPTCL.

Structural steel, rolled shapes, bars, etc. shall comply with the latest ASTM for A36.

Plate steel shall be of a designation and quality suitable for the function it is intended to perform. Insofar as it is compatible with its function, it shall comply with ASTM A283 structural quality.

All, or a representative number of such components, shall be subjected to one or more of the following tests: visual, dye penetration, magnetic particle (transverse and longitudinal), ultrasonic or radiographic. These tests shall be in accordance with the recommended practices of the ASTM. The terms of reference for acceptance shall be the applicable ASTM Specifications.

### **3.17.4 WELDING AND WELDERS QUALIFICATIONS**

#### **General**

All welding shall be carried out by qualified welders only.

All welding shall be in accordance with the corresponding standards of the American Welding Society or the American Society of Mechanical Engineers.

Other standards to determine the quality of welding process and qualifications of welders may be considered, provided that sufficient information is first submitted for the approval of the BHEL/OPTCL.

Prior to the start of fabrication, the Bidder shall submit to the BHEL/OPTCL for approval, a description of each of the welding procedures which he proposes to adopt, together with certified copies of reports of the results from tests made in accordance with these procedures.

The Bidder shall be responsible for the quality of the work performed by his welding organisation. All welding operators, to be assigned work, including repair of casting, shall pass the required tests for qualification of welding procedures and operators. The BHEL/OPTCL reserves the right to witness the qualification tests for welding procedures and operators and the mechanical tests at the samples.

The Bidder shall bear all his own expenses in connection with the qualification tests. If the work of any operator at any time appears questionable, such operator will be required to pass appropriate prequalification tests as specified by the Inspector and at the expense of the Bidder.

#### **Welding**

All welding shall be performed in accordance with the appropriate standards. The design and construction of welded joints subject to hydraulic pressure shall conform to the applicable requirement of ASME "Boiler and Pressure Vessel Code" shall be qualified in accordance with Section IX of this Code. The design and construction of welded joints not subjected to hydraulic pressure shall, as a minimum, conform to the requirements of AWS "Specification for Welded Highway and Railway Bridge" D2.0. Except for minor parts and items specifically exempted from stress relieving, all shop welded joints shall be stress relieved in accordance with the requirements of the ASME "Boiler and Pressure Vessel Code" Section VIII. In addition to satisfying the procedural and quality requirements set forth in the applicable code and/or these Specifications, all welding shall meet the following requirements for workmanship and visual quality:

- Butt welds shall be slightly convex, of uniform height and shall have full penetration.
- Fillet welds shall be of the specified size, with full throat and legs of equal length.

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- Repairing, chipping and grinding of welds shall be done in a manner which will not gouge, groove or reduce the thickness of the base metal.
- The edges of the member to be joined shall expose sound metal, free from laminations, surface defects caused by shearing or flame-cutting operations or other injurious defects.

Welded joints subject to critical working stress shall be tested by approved methods of non-destructive testing, such as radiographic and ultrasonic examination, magnetic particle and liquid penetration inspection. All expenses in connection with these tests shall be borne by the Bidder. The extent of testing shall be as stipulated by the ASME „Boiler and Pressure Vessel Code”, Section VIII, but without prejudice to the rights of the Inspector or the BHEL/OPTCL to ask for additional tests,

The arc-welding process to be used and the welding qualifications of the welders employed on the work shall be used in accordance with AWS requirements and Section VIII and IX of the ASME (American Society of Mechanical Engineers) Code, latest edition, as they may apply. All welding rods shall conform to the requirements of the latest issue of Section It, part C of the ASME Code.

Gas shielded welding (TIG or MIG) used as appropriate for aluminium, stainless steel or other material shall be carried out in accordance with the best commercial practice and the following standard specifications:

- Specifications for copper and copper-alloy welding rods (AWS A5.7, ASTM B259)
- Specification for corrosion-resisting chromium and chromium-nickel steel welding rods and bare electrodes (AWS A5.9, ASTM A371)
- Specifications for aluminium and aluminium alloy rods and bare electrodes (AWS A5.10, ASTM B285).
- Specifications for nickel and nickel-base alloy bare welding filler metal (AWS A5.14, ASTM B304).

Gas welding will not normally be used in the equipment. When a particular equipment manufacture requires the use of gas welding, the proposed process and the welder’s qualification shall be in accordance with AWS B3.0.

Welding of galvanised components will not be allowed in the equipment.

Strict measures of quality control shall be exercised throughout the Equipment/ Works. The BHEL/OPTCL may call for an adequate NDT test of the work of any operator, who in his opinion is not maintaining the standard of workmanship. Should this NDT test prove defective, all work done by that operator, since his last test shall be tested at the Bidder’s expense. If three or more of these tests prove defective, the operator shall be removed from the project.

A procedure for the repair of defects shall be submitted to the BHEL/OPTCL for his approval prior to any repairs being made.

### **Welding of pipes**

Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.

Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

Welding shall be done by manual oxy-acetylene or manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of BHEL/OPTCL.

As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

Downward technique is not allowed while welding pipes in horizontal position, unless permitted by the BHEL/OPTCL.

Combination of welding processes or usage of electrodes of different classes or makes in a particular joint shall be allowed only after the welding procedure has been duly qualified and approved by the BHEL/OPTCL.

No backing ring shall be used for circumferential butt welds.

Welding carried out in ambient temperature of 5C or below shall be heat treated.

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A spacer wire of proper diameter may be used for weld root opening but must be removed after tack welding and before applying root run.

Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.

Electrodes size for tack welding shall be selected depending upon the root opening.

Tack welds should be equally spaced.

Root run shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.

The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping. During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.

Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

### **3.18 QUALITY ASSURANCE**

#### **3.18.1 GENERAL**

To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Bidder's works or at his Sub-Bidder's premises or at Site or at any other place of work are in accordance with the Specification, with the Regulations and with relevant Indian or otherwise Authorized Standards the Bidder shall adopt suitable Quality Assurance Programs and Procedures to ensure that all activities are being controlled as necessary.

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.

The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.

These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in writing. All deviations to this specification,

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approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Dispatch Clearance Certificate (MDCC).

All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

### **3.18.2 SUB-VENDOR**

The Bidder shall ensure that the Quality Assurance requirements of this Specification are followed by any sub-vendor appointed by him under the Contract.

The Bidder shall assess the sub-vendor's Quality Assurance arrangements prior to his appointment to ensure its compliance with the appropriate ISO 9000 standard and the Specification.

Auditing of the sub-vendor's Quality Assurance arrangements shall be carried out by the Bidder and recorded in such a manner that demonstrates to the OPTCL/BHEL the extent of the audits and their effectiveness.

### **3.18.3 QUALITY ASSURANCE DOCUMENTS**

The Bidder shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identified in respective quality plan with tick (v) mark.

Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks.

Typical contents of Quality Assurance Document are as below:-

- i) Quality Plan,
- ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
- iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

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- iv) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- v) Heat Treatment Certificate/Record (Time- temperature Chart)
- vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Bidder for the agreed Customer Hold Points.
- viii) Certificate of Conformance (COC) whoever applicable.
- ix) MDCC

Before dispatch/ commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
- ii) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
- iii) If a decision is made for dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

#### **3.18.4 TRANSMISSION OF QUALITY DOCUMENTS**

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer on release of QA Documentation by Inspector. One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery similarly as stated above.

#### **3.18.5 INSPECTION, TESTING & INSPECTION CERTIFICATE**

- i. The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.
- ii. The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.

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- iii. The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
- iv. The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
- v. When the factory tests have been completed at the Bidder's or sub-bidder's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- vi. In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Bidder and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.
- vii. The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.
- viii. To facilitate advance planning of inspection in addition to giving inspection notice, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- ix. All inspection, measuring and test equipment used by bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.

### **3.19 TYPE, ROUTINE & ACCEPTANCE TESTS:**

The Bidder shall carry out the tests stated in accordance with the conditions of this Specification, without extra charge for such additional tests as in the opinion of the BHEL/OPTCL are necessary to determine that the Contract Works comply with this Specification. The tests shall be carried out generally in accordance

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with the relevant IEC"s or IS or equivalent standards. The specific details of testing and inspection are given in the appropriate section of this Specification.

The Bidder shall submit Type Test Reports for all equipment being supplied by him for the BHEL/OPTCL"s approval. The BHEL/OPTCL may also give instruction to carry out Type Tests, routine tests or acceptance tests. Type Test Charges shall be paid as per the rates indicated in the Price Schedules.

All materials used shall be subjected to such routine tests as are customary in the manufacture of the types of plant included in the Contract Works. These materials shall withstand satisfactorily all such tests.

All tests shall be carried out to the satisfaction of the BHEL/OPTCL, in his presence, at such reasonable times as he may require, unless agreed otherwise. Not less than three weeks' notice of all tests shall be given to the BHEL/OPTCL in order that he may be represented if he so desires. As many tests as possible shall be arranged together. Six copies of the Bidder"s test reports and test sheets shall be supplied to the BHEL/OPTCL for approval.

Measuring apparatus shall be approved by the OPTCL/BHEL (Divisional Engr) and if required shall be calibrated at the expense of the Bidder at an approved laboratory.

The Bidder shall be responsible for the proper testing of the work completed or plant or materials supplied by a sub-bidder to the same extent as if the work, plant or materials were completed or supplied by the Bidder himself.

All apparatus, instruments and connections required for the above tests shall be provided by the Bidder, but the BHEL/OPTCL may permit the use for the tests on site, any instruments and apparatus which may be provided permanently on site as part of the contract works conditional upon the Bidder accepting liability for any damage which may be sustained by such equipment during the test.

The bidder shall supply suitable test pieces of all materials as required by the BHEL/OPTCL. If required by the BHEL/OPTCL, test specimens shall be prepared for check testing and forwarded at the expense of the Bidder to an independent testing authority selected by the BHEL/OPTCL.

Any costs incurred by the Employer in connection with inspection and re-testing as a result of a failure of the subject under test, or damage during transport, or erection on site before take-over by the Employer, shall be to the account of the Bidder.

No inspection or lack of inspection or passing by the BHEL/OPTCL of work, plant or materials, whether carried out or supplied by the Bidder or sub-bidder, shall relieve the Bidder from his liability to complete the Contract Works in accordance with the Contract or exonerate him from any of his guarantees.

### **3.20.1 TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS**

- a) All equipment to be supplied shall be of type tested design. During detail engineering, the bidder shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of techno-commercial bid opening (03-March-2017). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.
- b) However if bidder is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of techno-commercial bid opening (**11-February-2022**), or in the case of type test report(s) are not found to be meeting the specification requirements, the bidder shall conduct all such

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- tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.
- c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

### **3.20 PACKAGING & TRANSPORTATION**

The Bidder shall be responsible for the packing, loading and transport of the plant and equipment from the place of manufacture, whether this is at his own works or those of any Bidder, to Site, and for off-loading at site.

All apparatus and equipment shall be carefully packed for transport by air, sea, rail and road as necessary and in such a manner that it is protected against tropical climate conditions and transport in rough terrain and cross country road conditions. The method of packing shall provide complete protection to all apparatus and equipment during transport and storage at site in heavy rain. The method of packing shall provide adequate protection to main items of plant and those parts contained within and attached without, for transportation.

Precautions shall be taken to protect parts containing electrical insulation against the ingress of moisture. All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected. The machined face of all flanges shall be protected by means of a blank disc bolted to each face.

Where appropriate all parts shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Each crate or container shall be marked clearly on the outside of the case to show "TOP" and "BOTTOM" positions with appropriate signs, and where the mass is bearing and the correct position for slings. Each crate or container shall also be marked with the notation of the part or parts contained therein, contract number and port of destination. It shall be the Bidder's responsibility to dispose of all such packing.

Any damage due to defective or insufficient packing shall be made good by the Bidder at his own expense and within reasonable time when called upon by the BHEL/OPTCL to do so. Four (4) copies of complete packing lists showing the number, size, marks, mass and contents of each package shall be delivered to the BHEL/OPTCL immediately the material is despatched.

The Bidder shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Bidder shall also be responsible for verifying the access facilities specified.

The Bidder shall be responsible for all costs of repair or replacement of the equipment, including those incurred by the Employer, arising from damage during transport, off-loading or erection on site, until take-over by the Employer.

The Bidder shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Bidder shall immediately report to the BHEL/OPTCL any claims made against the Bidder arising out of alleged damage to a highway or bridge.

### **3.21 ENCLOSURES:**

1. ANNEXURE – A: SPECIFICATION FOR ELECTRICAL COMPONENTS

**NOTE:**

Contractor is to be replaced with subcontractor/vendor.

## 1. MOTORS

### 1.1 General

All motors shall comply with IEC 34 / IS 335 and dimensions with IEC 72, however they shall be capable of operating continuously under actual service conditions without exceeding the specified temperature rises, determined by resistance, at any frequency between 48 and 51.5 Hertz together with any voltage between  $\pm 10$  per cent of the nominal value.

All motors shall be totally enclosed, and if situated in the open they shall be weatherproof and suitable for outdoor working. They shall be provided with a suitable means of drainage to prevent accumulation of water due to condensation and with suitable means of breathing.

Motors operating in an ambient temperature not exceeding 40°C shall have insulation to at least Class B and preferably Class F standards. The temperature rise shall be restricted to that associated with Class B insulation. Where the motor may be appreciably affected by conducted heat the class of insulation shall be to approval.

All motors shall be suitable for direct starting at full voltage.

Motors shall have sealed ball or roller bearings.

The three line connections of AC motors shall be brought out to a terminal box. The terminal arrangement shall be suitable for the reception of aluminium cable. Terminal markings shall be made in a clear and permanent manner and shall comply with IEC 34. A permanently attached diagram or instruction sheet shall be provided giving the connections for the required direction of rotation. All terminal boxes shall be of the totally enclosed type designed to exclude the entry of dust and moisture and sealed from the internal air circuit of the motor. All joints shall be flanged with gaskets of neoprene or other approved material. Natural rubber insulation shall not be used.

Motors rated above 1 kW shall be three phase motors. Where single phase motors are employed the motors shall be grouped so as to form an approximately balanced three phase load.

### 1.2 Motor control gear

Control gear shall comply with the requirements of IEC 292, the control gear being rated according to the duty imposed by the particular application.

Motor contactors shall comply with IEC 158 class of intermittent duty 0-3 with type 52 enclosure protection. Apparatus shall be capable of switching the stalled current, and shall have a continuous current rating of at least 50 per cent greater than the full load current of the motors they control.

The operating currents of overload trips fitted to motor contactors shall be substantially independent of ambient temperature conditions, including the effect of direct sunlight on the enclosure in which the contactors are installed.

Where small motors are connected in groups, the group protection shall be arranged so that it will operate satisfactorily in the event of a fault occurring on a single motor. The control and protection equipment shall be accommodated in the control cabinet or marshalling kiosk.

Each motor or group of motors shall be provided with control gear for starting and stopping by hand and automatically. Overload and single-phasing protection shall be provided.

## 2.0 CABLE BOXES

Cable boxes shall be suitable for cables entering from above or below as may be required. They shall be weatherproof, rodent and insect-proof and be complete with all gaskets, compression glands, wiping glands and all associated fittings as may be required to make-off the cables.

Gland plates shall be insulated from the cable boxes and, in the case of single core cables, shall be of non-magnetic or insulating material. If metallic gland plates are used, single core cable glands shall be insulated from the gland plate. Gland plate insulation shall be capable of withstanding a dry high voltage test of 2000volts ac for one minute.

Where cable boxes are provided for three core cables, the sockets on the outer phases shall be inclined towards the centre to minimise opening of the cable cores. Cable sockets shall be supplied under this Contract.

Cable boxes for voltages up to and including 11kV shall be suitable for PVC or XLPE insulated steel wire-armoured PVC served cables. The boxes shall be air insulated and designed to accommodate all the fittings required by the cable manufacturer. Front covers and gland plates shall be removable and a 12mm diameter breathing hole covered with a wire gauze shall be provided.

Cable boxes shall be capable of withstanding on site the cable high voltage test level in accordance with IEC 502.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables not included in the Contract scope of work shall be carried out under a separate contract.

Connection of the power cables included in the Contract scope of works shall be carried out under this Contract.

### **3.0 TERMINAL BOARDS AND TERMINAL BLOCKS**

Terminal boards shall be of good quality non-flammable insulating material with a comparative tracking index (CTI) of not less than 500 to IEC112.

Terminal boards shall be spaced not less than 150 mm apart. For relay panels, they shall be mounted at the sides of the cubicle, and set obliquely towards the rear doors to give easy access to termination and to enable ferrule numbers to be read without difficulty.

Studs of stud type terminal boards shall be locked in the base to prevent turning and all connections shall be made on the front of the terminal board using lock nuts or lock washers. Where crimped type termination are provided at least two sets of crimping tools for each size of crimp must be supplied for each installation.

Terminals shall be of the insertion clamp type incorporating captive pressure screws which do not bear directly on the wire but on a serrated clamping plate. The pressure screws shall have an inherent locking feature.

Where connections are to be made between multi-core cables and telephone type multi-pair cables, the terminal blocks shall be of the insulation displacement type and shall have a withdrawable insulated link in order to facilitate isolation (or busy out in the case of the apparatus associated with the telephone system) of the individual circuits. These terminals shall also be provided with facilities for the insertion of test probes on both sides of the link.

All terminations shall be numbered for identification and grouped according to function. Engraved white on black labels shall be provided on the terminal blocks.

Terminals for connections which exceed 110 Volts shall be separated from those of other circuits and shall be fitted with insulating screens and "DANGER" notices.

The use of terminal blocks as junction points for wires which are not required in the associated cubicle shall be avoided wherever practicable.

All termination racks shall have a minimum of 20 per cent spare terminals blocks. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

All internal wiring to be connected to external equipments shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be 650 V grade and have

10A continuous rating. Terminal blocks shall be moulded in one piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Terminal blocks shall include a white fibre marking strip with clear plastic, slip-on/clip-on terminal covers. Markings on the terminal strips shall correspond to terminal numbers on the wiring diagrams.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Current transformer secondary leads shall be provided with short circuiting and earthing facilities.

All terminal blocks shall be suitable for terminating on each side, two by 2.5 mm<sup>2</sup> standard copper conductors.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side :

- All CT and VT circuits : Minimum of two 2.5 mm<sup>2</sup> copper stranded.
- AC/DC power supply circuits : One 16 mm<sup>2</sup> aluminium.
- All other circuits : Minimum of one of 2.5 mm<sup>2</sup> copper stranded

There shall be a minimum clearance of 250 mm between the first row of terminal blocks and the associated cable gland plate or panel side wall, as per the terminal block mounting arrangement adopted. Also the clearance between the edges of two rows of terminal blocks shall be minimum of 150 mm.

Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal blocks opposite the wiring duct shall be reserved for external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold it firmly and to enable free and flexible termination without causing strain on terminals.

All necessary cable terminating accessories such as gland plates, supporting clamps and brackets, wiring troughs and gutters etc. including glands and lugs for cable shall be in bidders scope of supply.

#### **4.0 FUSES AND LINKS**

Carriers and bases for fuses and links shall be in accordance with IEC 269 and colour coded to permit identification of the circuit rating.

The fuses and links mounted in cubicles for tripping circuits and protective gear test links shall be mounted on the front of the panel. Other links and fuses shall be accommodated within the cubicle or above the cubicle doors. Fuses and links shall be grouped and spaced according to their function in order to facilitate identification.

All incoming circuits in which the voltage exceeds 125V shall be fed through insulated fuses and/or links, the supplies being connected to the bottom terminal. The contacts of the fixed portion of the fuse or link shall be shrouded so that accidental contact with live metal cannot be made when the moving portion is withdrawn.

Main supply fuse links shall be of the high rupturing capacity cartridge type.

Where fuse carriers are mounted vertically the incoming (supply) side shall be the bottom terminal.

Where either fuses or circuit breakers are used it should be ensured that proper discrimination between main and sub-circuits is maintained.

## 5.0 COMMUNICATIONS CABLES

All cables and wiring shall have copper conductors and PVC insulation and shall comply with IEC 227. Telephone type cables shall comply with IEC 96 and IEC 189.

Cabling and wiring installations shall be arranged to minimise the risk of fire and damage which may be caused in the event of fire.

For telephone type cables conductor wires with a cross sectional area of less than 0.2 mm<sup>2</sup> shall not be used. Where twin or quad make up is required in any cable the cores shall be uniformly twisted and the lays arranged such that crosstalk is reduced to a minimum.

No conductor smaller than 32/0.2mm (1mm<sup>2</sup>), or having less than three strands shall be used for interconnecting cabling except in the case of telephone cables. All cables shall have insulation which will withstand the highest temperature to be experienced in service.

Each conductor of a multi-core cable shall be readily identified by a numbered marker tape or, in the case of telephone type cables, colour coded insulation.

The Bidder shall submit full details of all loading on cables and in the case of interposing current transformer connections, the loop resistance of each circuit.

Apparatus cubicles, cabinets, racks and panels shall be provided with gland plates and all necessary equipment for the termination of cables. The Contract Works shall include for the checking, termination and ferruling of the cable cores and their lacing into cable forms and connection to the equipment terminal boards or tag blocks using claw washers. Crimping ferrules shall be used for each conductor.

## 6.0 MARSHALLING KIOSKS AND CONTROL CABINETS

The bidder shall provide within every bay of the switch yard a bay marshalling kiosk to which all incoming and outgoing connections to and from the associated bay equipment will be run. The terminal blocks within the kiosks shall be grouped together by function and shall be properly labelled and segregated. Transformer and circuit breaker control/marshalling kiosks will be provided under a separate contract, but it shall be the contractor's responsibility to cable up to the control/marshalling kiosks as provided by the transformer and circuit breaker suppliers. The Contractor shall provide a separate stand alone kiosk for busbar protection CT marshalling and the kiosk shall house the CT shorting and switching relays required for the correct function of the busbar protection scheme.

All outdoor cabinets and kiosks shall be protected in accordance with Class IP55 of IEC 947-1 and shall be insect and rodent proof. The minimum sheet steel thickness for all cubicles, kiosks and panels shall be not less than 2 mm cold rolled or 2.5 mm hot rolled sheet steel. The top of the outdoor boxes/kiosks shall be provided with Aluminium alloy sheets having 2 mm thick with proper sloping for easy discharge of water.

Anti-condensation heaters, 240V AC single phase, shall be provided and shall be controlled by a watertight switch mounted externally. Ventilation louvres shall be provided, suitably lined internally with a mesh screen, and divisions between compartments shall be perforated.

Control cabinets shall be illuminated with a switch operated and fused 240V CFL tube. Control cabinets shall be provided with a switch operated single phase 240V 15A power socket.

All cables shall enter cabinets and kiosks at the base.

Each compartment of all kiosks and cabinets shall be provided with access doors at the front and rear. Doors and access covers shall not be secured by nuts and bolts but shall be fastened with integral handles with provision for locking with a padlock.

Doors for kiosks shall be of the lift off and hinged type and shall be provided with glazed windows of adequate size to facilitate reading of indicators from outside the kiosk. Facilities shall be provided to permit removal of the temperature indicators without the need to pass the capillary tubing and bulb through the various compartments.

Doors and covers under 15kg mass may be of the slide on pattern, but above this mass hinged doors shall be used. Door shall be provided with padlocking facilities.

When three phase connections rated at 380V and above are taken through cabinets or kiosks, the terminal blocks shall be adequately screened, insulated and suitably marked with the phase colour; "DANGER" notices shall be affixed to the terminal blocks and a DANGER notice stating the voltage shall be fixed on the inside and outside of the kiosk or cabinet. Exterior DANGER notices shall be stove enamelled and shall be written in English and Oriya and shall be of an approved class/grade.

A durable copy of the circuit wiring diagram shall be affixed to the back of the kiosk door and labels shall be provided inside each kiosk or box to describe the functions of the various items of equipment.

When the marshalling kiosks are positioned in side the switchyard , flood water shall not ingress in to the marshalling kisok. The contractor/bidder may achieve the same either positioning the marshalling kiosk appropriately or providing adequate water proof arrangement.

**CT, CVT & IVT outdoor kiosks shall be of Aluminium alloy sheets having 3mm thickness. It shall have proper slop canopy for easy drainage of water.**

## 7.0 AUXILIARY SWITCHES

With each disconnecter, contactor and earthing device, there shall be supplied all necessary auxiliary switches and mechanisms for indication, protection, control, interlocking, supervisory and other services as specified. Not less than four spare auxiliary switches of each type shall be provided.

All auxiliary switches shall be wired up to a suitable terminal board on the fixed portion of the switchgear whether they are in use or not in the first instance, and shall be arranged in the same sequence on all similar items of equipment. Switches shall be provided to interrupt the supply of current to the tripping mechanism of the circuit breakers and latched contactors. All such switches and mechanisms shall be mounted in accessible positions clear of the operating mechanism, and shall be adequately protected.

The contacts of all auxiliary switches shall be strong and be capable of adjustment in relation to the movement of the circuit breaker or other item of equipment. Auxiliary switches and auxiliary circuits shall be capable of carrying a continuous current of 10 Amps.

## 8.0 MINIATURE OR MOULDED CASE CIRCUIT BREAKERS

Miniature or moulded case circuit breakers (MCB's or MCCB's) shall be designed and tested in accordance with IEC 157 and supplementary requirements of this specification. They shall be suitable for use over the full range of expected voltage variation as specified in the Schedules.

MCB's and MCCB's shall be suitably rated for both the continuous and short circuit loading of the circuits they are protecting under all service and atmospheric conditions stated in the specification. The bidder shall ensure that correct discrimination is maintained between main and sub-circuits.

For three phase circuits, the miniature circuit breakers shall be of the three pole type; for single phase circuits they shall be of the single pole type and for dc circuits they shall be of the double pole type.

Where miniature circuit breakers are used in circuits containing inductive loads, e.g. operating coils, it is essential that they are suitable for satisfactory operation in the circuit in which they are used, i.e. account is taken of the circuit time constant.

All miniature circuit breakers shall be provided with an auxiliary contact for remote indication of circuit breaker operation.

Means shall be provided to prevent the miniature circuit breakers being inadvertently switched to the „OFF“ position.

Miniature circuit breakers shall be mounted in such a manner so as to give easily visible indication of breaker position and shall be grouped and spaced according to their function in order to facilitate identification and easy replacement.

## **9.0 SPACE HEATERS**

Heaters shall be suitably designed to prevent any contact between the heater wire and the air. They shall consist of coiled resistance wire centred in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties, or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air.

Alternatively, they may consist of a resistance wire mounted into a tubular ceramic body built into an envelop of stainless steel or the resistance wire wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

## **10.0 LVAC CABLES**

### **10.1 General**

LVAC power cables shall have aluminium conductors with XLPE insulation, galvanised steel wire armour and PVC oversheath and shall comply with the requirements of IEC 227, 228 and 502 as applicable. Cables shall be sized to carry the highest anticipated load under the worst case ambient conditions. Where a three, three and a half or four core power cable is provided, the cores shall be coloured to distinguish the relevant phases.

All sheaths shall be free from defects and impervious to water.

### **10.2 1.1kV grade power and control cables**

#### **10.2.1 Codes and Standards**

The design, manufacture, testing and performance of cables covered under this specification shall comply with latest edition of the standards including amendments as indicated in the relevant schedules attached to this specification.

#### **10.2.2 Technical requirements**

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled backfill and chances of flooding by water.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE insulated LV power cables shall withstand without damage a three phase fault current of at least 45 kA for a minimum of 0.12 seconds, with an initial peak of 105 kA in one of the phases. The armour for XLPE insulated power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

Strip wire armouring following method (a) of the relevant IS shall not be accepted for any of the cables. For control cables round wire armouring only shall be used.

Cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

All the cables shall pass fire resistance test as per IS 1554 (Part-I)

The normal current rating of all PVC insulated cables shall be as per IS 3961.

Repaired cables shall not be accepted.

### **10.3 LV XLPE power cables**

XLPE insulated cables shall conform to IS 7098 (Part-I) and its amendments read along with this Specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multi-core cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multi-core cables even if they are unarmoured. For armoured or unarmoured cables, the inner sheath shall be of extruded PVC to type ST-2 of IS 5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips.

### **10.4 LV XLPE power cables**

PVC (70C) insulated 1100V grade power cables shall conform to IS 1554 (Part-I) and its amendments, read along with this Specification and shall be suitable for a steady conductor temperature of 70°C . The conductor shall be stranded aluminium. Insulation shall be extruded PVC to type-A of IS 5831. A distinct inner sheath shall be provided in all multi-core cables. For multi-core armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS 5831 for all cables.

### **10.5 LV PVC control cables**

The 1100V grade control cables shall conform to IS 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The oversheath shall be extruded PVC to type ST-1 of IS 5831 and shall be grey in colour except where specifically advised by the Project Manager to be black.

Cores shall be identified as per IS 1554 (Part-1) for cables up to five cores and for cables with more than five cores the identification of cores shall additionally be done by printing legible alphabets on all cores. The alphabets shall be white and shall be printed at approximately 100 mm intervals along the cable length. Cables without such core identifications will not be accepted.

### **10.6 Cable drums**

Cables shall be supplied non-returnable wooden or steel drums of heavy construction. Wooden drums shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The Project Manager shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of  $\pm 2\%$ .

A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

### **10.7 Tests**

All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

The temperature index tests shall be carried out as per ASTM-D-2863.

All cables shall meet the fire-resistance test as per IS 1554 (Part-I)

### **10.8 Cable sizes**

Following standard sizes of cables shall be considered by Bidder for various power distribution and protection, control and metering purposes in the system:

- XLPE power cables: 1c 630 mm<sup>2</sup>, 1c 300 mm<sup>2</sup>, 3 1/2c 300 mm<sup>2</sup>. (armoured)
- LV XLPE power cables: (armoured) 1c 150 mm<sup>2</sup>, 3 1/2 c70 mm<sup>2</sup>, 3 1/2c 35 mm<sup>2</sup>, 4c 16 mm<sup>2</sup>, 4c 6 mm<sup>2</sup>, 2c 6 mm<sup>2</sup>.
- PVC control cables: 2c 2.5 mm<sup>2</sup>, 3c 2.5 mm<sup>2</sup>, 5c 2.5 mm<sup>2</sup>, 7c 2.5 mm<sup>2</sup>, 10c 2.5 mm<sup>2</sup>, 14c 2.5 mm<sup>2</sup>, 19c 2.5 mm<sup>2</sup>, 27c 2.5 mm<sup>2</sup>

## 11.0 BUSHINGS

All bushings shall comply with the requirements of IEC 137 and the associated barrel porcelains shall comply with IEC 233 together with the requirements of this Specification. Provision shall be made for the fitting of arcing horns.

Transformer bushings rated at 66 kV and above shall be either of the oil impregnated paper or resin impregnated type. When filled with transformer oil there shall be no connection with the oil in the transformer and an oil gauge shall be provided. The visible oil levels in the gauge shall correspond to the range of average oil temperatures, from the minimum ambient stated in the Schedules to plus 70C. The oil level at 15C shall be marked. Connections from the main windings to bushings shall be flexible and shall be such that undue mechanical stresses are not imposed on them during assembly on site.

Terminal clamps shall be supplied with each bushing for flexible or rigid busbars as may be required. The material of the clamps shall be as stated in the Schedules.

## 12.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

Bushings shall be manufactured and tested in accordance with IS 2099 and IEC 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IS 2099/IEC 273. The insulators shall also conform to IEC 815 as applicable.

The bidder may also offer composite silicon insulators conforming to IEC 36.

Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and other similar defects.

Support insulators, bushings and hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators or bushings when operating at the normal rated voltage.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up, porcelain parts by grinding and metal parts by machining. Insulator and bushing design shall be such as to ensure a uniform compressive pressure on the joints.

## 12.1 Tests

In accordance with the requirements stipulated above bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS 2099 and IS 2544.

All routine tests shall be conducted on hollow column insulators as per IEC 233. In addition the following tests shall also be conducted

1. Ultrasonic test as a routine test.
2. Pressure test as a routine test.
3. Bending load test in four directions at 50% specified bending load, as a routine test.
4. Bending load test in four directions at 100% specified bending load, as a sample test on each lot.
5. Burst pressure test as a sample test on each lot.
6. Hollow porcelain insulators should be in one integral piece in green and fired stage. No jointed porcelain will be acceptable.

## 12.2 Technical parameters of bushings, hollow column insulators and support insulators:

Parameter	420kV	245kV	145kV	36kV
Rated voltage kV	420	245	145	36
Impulse withstand (wet and dry) kVp	±1425	±1050	±650	±170
Switching surge withstand (wet and dry) kVp	±1050			
Power frequency withstand (wet and dry) kVrms	630	460	275	70
Total creepage distance mm	10500	6125	3625	900

Pollution level shall be Class III Heavy as per IEC 71, and as specified in Schedules for all classes of equipment.

Insulators shall also meet the requirements of IEC 815 for 420kV, 245kV and 145kV systems as applicable having alternate long and short sheds.

## 13.0 CIRCUIT BREAKERS

### 13.1 General

Circuit breakers shall be of three pole air break design, horizontal draw out type in accordance with IEC 947-2. In particular, evidence shall be provided of the performance when switching currents in the critical current range. They shall be capable of the ratings specified in the Schedules, when mounted in the switchboard.

Circuit breakers shall be fitted with trip-free, spring-operated mechanisms of the independent manually operated type and be provided with making and over current release facilities. A push-button shall be provided to trip the breaker electrically.

The breaker shall be provided with '**OPEN**', '**CLOSE**', '**SERVICE**', '**TEST**' and '**SPRING CHARGED**' position indicators and shall be provided with the necessary number of auxiliary contacts for interlocking, indication and tripping purposes plus two spare.

Each incoming circuit shall be provided with thermal overload relays and short circuit protection relays; they shall also be provided with an undervoltage relay to trip breaker in the event of a supply failure.

There shall be 'SERVICE', 'TEST' and fully withdrawn positions for the breakers. It shall be possible to close the door in „TEST' position.

Movement of a circuit breaker between „SERVICE' and „TEST' positions shall not be possible unless it is in „OPEN' position. Attempted withdrawal of a closed circuit breaker shall not trip the circuit breaker.

Closing of a circuit breaker shall not be possible unless it is in „SERVICE', „TEST' or fully withdrawn positions.

A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

Circuit breakers shall be provided with electrical anti-pumping and trip free feature.

Means shall be provided to slowly close the circuit breaker in withdrawn position if required for inspection and setting of contacts. In service position slow closing shall not be possible.

Circuit breakers shall be provided with the following mechanism as specified in the Bill of Material.

### **13.2 Power operated mechanism**

Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class 'E' or better.

The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.

Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.

The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically be mechanically decoupled.

All circuit breakers shall be provided with closing and tripping coils. The closing coils shall operate correctly at all values of voltage between 85% to 110% at rated control voltage. Tripping coils shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.

Provision for mechanical closing of the breaker only in 'TEST' and withdrawn positions shall be made.

### **14.0 RELAYS**

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. Auxiliary relays and timers may be furnished in non-drawout cases.

All AC relays shall be suitable for operation at 50 Hz with 110 volts VT secondary and 1A or 5A CT secondary.

All protective relays and timers shall have at least two potential free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate numbers of terminals shall be available on the relay cases for applicable relaying schemes.

All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flags) for analysing the cause of operation.

All relays shall withstand a test voltage of 2kV (rms) for one minute.

Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type terminal overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

All fuse protected, contactor controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bi-metallic strips), or as a separate device. The single phasing protection shall operate with 80% of the set current flowing in two of the phases.

## **15.0 CONTACTORS**

Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IS 2959.

Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.

Direct line starter contactors shall be of utilisation category AC2. These contactors shall be as per IS 1822.

Each contactor shall be provided with two normally open (NO) and two normally close (NC) auxiliary contacts.

Operating coils of contactors shall be of 240V AC unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. Contactors shall drop out at 70% of the rated voltage.

## **16.0 INSTRUMENT TRANSFORMERS**

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.

All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

Current transformers may be multi or single core type. All voltage transformers shall be single phase type. Busbar VT's shall be housed in a separate compartment.

All VT's shall have readily accessible HRC current limiting fuses on both primary and secondary sides.

## **17.0 INDICATING INSTRUMENTS**

All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

Watt-hour meters shall be of three phase, three element type. Maximum demand indicators need not be provided.

## 18.0 CONTROL AND SELECTOR SWITCHES

Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show the function and positions. Switches shall be suitable for flush mounting with only switch front plate and operating handle projecting from the panel front. Switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. Handles of different shapes along with suitable inscriptions on switches shall be provided as an aid to switch identification. The selection of operating handles for the different types of switches shall be as follows :

Switch Type	Application	Specification
Switchgear control switches	For closing and opening of breakers and isolators.	Pistol grip, black, three position type.
Synchronising switches	For synchronising check bypass facilities	Oval, black, keyed (common removable handle, or with locking facility and common key).
Selector switches	Auto, manual, local, remote and test facilities	Oval or knob, black
Instrument switches	Phase or meter selection	Round, knurled, black
Protection transfer switch	Transfer of protection.	Pistol grip, lockable and black.

**TABLE 18.1 Switch operating handles**

The control switches of breakers and isolators shall be of spring return to neutral type. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The spring return type switch shall have spring return from close and trip positions to “after close” and “after trip” positions respectively. They shall have at least two (2) contacts closing in close positions, and two (2) contacts closing in Trip positions unless specified otherwise.

Circuit breaker selector switches for breaker controlled motors shall have three stay put positions marked „**AUTO**’, „**MANUAL**’ and „**TEST**’ respectively. They shall have two contacts each of three positions and shall have black, pistol grip handles.

Instrument selection switches shall be of maintained contact stayput type. Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondaries when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line-to-line and line-to-neutral voltages for non effectively earthed systems, and for reading all line to line voltages for effectively earthed systems. Ammeter and voltmeter selector switches shall have four stayput positions with an adequate number of contacts for three phase four wire systems. These shall have black oval handles

Synchronising switches shall be of maintained contact stayput type having a common removable handle for a group of switches. The handle shall be removable only in the „**OFF**’ position and it shall be co-ordinated to fit in to all the synchronising switches. These switches shall be arranged to connect the synchronising equipment when turned to the „**ON**” position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the „**ON**” position.

Lockable type switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts.

The contact combination and their operation shall be such as to give completeness to the interlocking and function of the scheme. The contact rating of the switches shall be as follows :

Description	Contact rating in Amps		
	220V DC	50V DC	240V AC
Make and carry continuously	10A	10A	10A
Make and carry Make and carry for 0.5 sec.	30A	30A	30A
Break			
Resistive load	3A	20A	7A
Inductive Load with L/R=40ms	0.2A	—	—

**TABLE 18.2 Contact ratings of switches**

## 19.0 AIR BREAK SWITCHES

Air breaker switches shall be of the heavy duty, single throw group operated, load break, fault make type complying with IS 4064.

The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.

Switch operating handles shall be provided with padlocking facilities to lock them in 'OFF' position.

Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in 'OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

## 20.0 PUSH BUTTONS

Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 240V and 0.5A (inductive) at 220V DC.

All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push-buttons shall be provided with integral escutcheon plates marked with the appropriate function.

The colour of the button shall be as follows :

- GREEN** : For motor **START**, breaker **CLOSE**, valve /damper **OPEN**
- RED** : For motor **TRIP**, breaker **OPEN**, valve /damper **CLOSE**
- BLACK** : For overload reset, all annunciator and miscellaneous functions.

All push-buttons on panels shall be located in such a way that red push buttons shall always be to the left of green push buttons.

## 21.0 INDICATING LAMPS

Indicating lamps shall be of the panel mounting filament type and low watt consumption. Lamps shall be provided with series resistors, preferably built-in the lamps assembly. The lamps shall have

escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp covers of colours appropriate to the application as indicated in Table 21.1

Colour	Indication
RED	For motor <b>ON</b> , breaker/isolator <b>CLOSED</b> , valve/damper <b>OPEN</b>
GREEN	For motor <b>OFF</b> , breaker /isolator <b>OPEN</b> , valve/damper <b>CLOSE</b>
WHITE	For motor <b>Auto-Trip</b>
BLUE	For all healthy conditions (e.g. control supply) and also for ' <b>SPRING CHARGED</b> '
AMBER	For all alarm conditions (e.g. overload) Also for ' <b>SERVICE</b> ' and ' <b>TEST</b> ' positions indicators.

**TABLE 21.1 Indicating lamp colours**

Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariably be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and amber lamps should normally be located above the red and green lamps.

When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button.

The wattage and resistance of the lamps shall be as follows:

- 220/250V      5 - 10W      4000 - 8000 ohms
- 110V          5 - 10W      1000 - 2000 ohms

Neon indicating lamps or LED's shall be provided when specified. The wattage of the neon lamp shall be 0.25 to 0.5W.

Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of supply.

All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

## 22.0 FUSES

All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be of Class 2 type, 20kA (RMS) breaking current at 415V AC, and for DC circuits Class 1 type 4kA breaking current.

Fuses shall have visible operation indicators.

Fuses shall be mounted on fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, they shall be directly mounted on plug in type bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

Fuse ratings shall be chosen by the bidder depending upon the circuit requirements and these shall be subject to approval of Project Manager.

## 23.0 NAME PLATES AND LABELS

All switchgears and ACDC distribution boards etc. shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also. Language shall conform to the requirements stipulated elsewhere in the technical specification..

All name plates shall be of non-rusting metal or 3-ply lamincoid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to Project Manager's approval.

Suitable plastic sticker labels shall be provided for easy identification of all equipment, located inside the panel or module. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the module wiring drawings.

## **24.0 ELECTRIC MOTORS (LV)**

### **24.1 Codes and Standards**

All motors shall conform to the latest revisions of the relevant IEC, Indian Standards, British Standards given in the schedules, except where modified or supplemented by this Specification.

The design, manufacture, installation and performance of motors shall conform to the provisions of latest Indian Electricity Act and Indian Electricity Rules. Nothing in these specifications shall be construed to relieve the bidder of his responsibility in this regard.

In case of contradiction between this specification and IS or BS or IEC, the stipulations on this specification shall prevail.

National Electrical Code for Hazardous locations and relevant NEMA standard shall also be applicable for motors located in hazardous location.

### **24.2 Service conditions and temperature rise**

Unless otherwise specified, machines shall be designed for a maximum ambient air temperature of 50C. Accordingly the temperature rise of the stator winding by resistance method over the ambient air temperature shall not exceed 70C.

For applications where the motor temperatures may be appreciably affected by conducted or radiated heat, the amount of heat must be specified by the bidder and the appropriate temperature rises agreed.

### **24.3 AC Motors**

#### **24.3.1 General**

All AC motors shall be of squirrel cage type, unless otherwise specified and shall be suitable for direct on line starting.

Each motor shall be assigned a maximum continuous rating (MCR) corresponding to 70C temperature. Maximum continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment at designed capacity.

Rated voltage for AC motors shall be as given below for various MCR's of the motor, unless specified otherwise:

- From 0.2 kW to 220 kW            415 V, three phase, 50 Hz
- Below 0.2 kW                      240 V, single phase, 50 Hz

Voltage and frequency variations shall be as per clause 3.3 of IS 325.

The lowest voltage at the motor terminals throughout the starting period, with which the driven equipment shall satisfactorily start up even under the most arduous conditions specified, shall be 85% for motors rated up to 110 kW, and 80% for motors rated above.

The accelerating torque at any speed with the lowest starting voltage shall be at least ten (10) percent of rated full load torque of the motor.

The motors shall be suitable for two starts in succession under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

The ratio of locked rotor kVA at rated voltage to rated kW (MCR corresponding to 70C temperature rises) shall not exceed the following (without any further tolerance):

<b>Motor MCR kW</b>	<b>Start kVA/Rated kW</b>
Up to 110kW	1.0
Above 110kW	10.0

When tests to determine the breakaway starting current of cage induction motors are taken at reduced voltage, due allowance shall be made for the effect of saturation. The estimated value of breakaway starting current at rated voltage shall be given on all test certificates.

All motors shall be so designed that the maximum inrush currents and locked rotor and pull out torque, developed by them at 110% of the rated voltage, do not endanger the motor or the driven equipment.

The pull out torque at rated voltage shall not be less than 200 percent of the full load torque.

Motors for reciprocating compressors etc. shall be specially designed/rated to withstand the torque pulsation produced by the driven equipment.

#### 24.3.2 Transient recovery

The motors shall be capable of resuming normal operation after a system disturbance causing temporary loss of supply voltage for periods of up to 0.2 second (fault clearance time), followed by sudden restoration to 70 percent rated voltage. From this voltage the motors shall be capable of acceleration and ultimate recovery under the most arduous load conditions.

### 24.4 DC Motors

DC motors shall comply with IS 4722 and shall be shunt wound type rated for 220V. Motor MCR kW rating at 50C ambient shall be at least ten percent higher than the power requirement of the driven equipment under the most onerous operating conditions foreseen during the plant's life.

DC motors which are to operate from batteries shall be capable of operating continuously under actual service conditions at any voltage between 190V and 240V.

DC motors supplied from rectifier equipment connected to AC power supplies shall meet the voltage and frequency variations specified for AC motors.

Rectifier equipment shall be capable of meeting the condition of transient recovery given above for AC motors and shall be provided with the necessary current limiting devices.

The pull-out torque of DC motors at the rated voltage shall not be less than 200 percent of the full load torque.

### 24.5 Enclosure and method of cooling

The following types of enclosure may be supplied:

- Totally enclosed, fan ventilated.
- Totally enclosed, closed air circuit, integral heat exchanger.
- Totally enclosed, closed air circuit, machine mounted heat exchanger.

In all cases protective enclosure and method of cooling of motors shall be IP 54 and IC 0141 in accordance with IS 4691 and IS 6362 respectively.

Cooling fans shall be directly driven from the motor shaft.

Motors situated outdoors or exposed to the weather shall be weather protected (IPW-55).

All totally enclosed type of motors shall have a dust tight construction with suitable means of breathing and of drainage to prevent accumulation of water from condensation. Drain holes shall exclude bodies greater than 6 mm diameter.

## 24.6 Constructional features

All components shall be of adequate mechanical strength and robustness and shall be constructed of metal unless otherwise approved. Glass fibre or plastic components, where employed, shall be of adequate design and robustness taking into account the conditions of service required and the effects of operating temperatures, ageing and thermal stability of the material. The material shall be resistant to flame propagation.

Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.

Motors and their major components such as stators, rotors, terminal boxes, bearings and heat exchangers shall be designed to be readily interchangeable as integral units.

All motor rotors shall be dynamically balanced.

The enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits.

The radial air gap between stator and rotor shall have an adequate margin to minimise the possibility of rubbing between the stator and rotor due to eccentric positioning, play and wear, shaft deflection due to rotor weight and unbalanced magnetic pull etc. The minimum radial air gap for all motors shall be in accordance with Clause 5.1.5 of IS 6381.

All requirements of clause 5.1.4 of IS 6381 shall also be complied with.

All the induction motors shall be capable of running at 75% of rated voltage for a period of 5 minutes.

Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during fast changeover of buses. The necessary features incorporated in the design to comply with this requirement shall be clearly indicated in this proposal.

## 24.7 Variable speed motors

Variable speed motors shall be such that the speed can be continuously adjusted over the required range. The speed control gear shall be provided with an interlock to ensure that the motor can only be started when its control sequence is at the correct setting. When the motor is switched off, the speed control sequence shall automatically return to this position.

## 24.8 Brush gear, commutators and slip-rings

Brush gear, commutators and slip-rings shall be designed to operate without injurious sparking and to run for at least three months without the need for adjustment or replacement of brushes.

Brushes shall be of electro graphite or metal graphite type. Adequate precautions shall be taken to protect the windings, commutators, slip-rings and brush gear against deposits of entrained carbon dust.

Removable covers shall be fitted to provide access to the brush gear, commutators and slip-rings. For totally enclosed type motors, windows shall be provided to permit observation of the brush gear whilst the motor is running.

Brush holders shall be of non-ferrous materials and located securely to accurately position the brushes on the commutator. Means for adjusting brush pressure and brush assembly shall be provided.

## 24.9 Internal electric heaters

Internal electric heaters shall be provided on motors rated above 30 kW, to maintain the windings in a dry condition during periods of standstill. The heater shall be suitable for use on a 240V, 50 Hz, AC supply.

#### **24.10 Lifting facilities**

All heavy parts of the motors shall be provided with adequate arrangements for lifting or handling during erection or overhaul.

All material used for equipment construction including castings and forging etc. shall be of tested quality as per relevant codes and standards. No welding shall be carried out on cast iron components for repair or any other purpose.

#### **24.11 Winding and insulation**

Winding insulation shall be of class B or better and of proven high quality and reliability.

All winding insulation shall be non-hygroscopic, oil resistant and of materials resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site during the installation period and also during normal operation.

All winding overhangs and leads shall be adequately supported, braced and blocked to provide sufficient rigidity during all normal conditions of service.

Cage windings and all joints shall be designed to give an adequate safety factor on fatigue due to thermal and mechanical stresses, taking into account the specified starting and running conditions. The short-circuiting and rings shall be of joint less construction. All electrical joints and connections shall be of brazed or welded construction.

Motors shall be designed to give a life endurance of at least 18000 starts.

#### **24.12 Bearings**

Bearings shall be of rolling type. Vertical motors shall normally have rolling type guide and thrust bearings.

Bearings shall be designed to prevent ingress of dust and water and shall be sealed against leakage of lubricant along the shaft.

When the motor shaft is not located axially by its own bearings, it shall be permanently marked to indicate its normal running position and the extent of float in either direction.

Bearings shall comply with the relevant Indian or International Standards. The bearing housing shall be correctly packed with lithium based grease at the time of assembly. Construction shall be such that the bearings can be dismantled without risk of damage.

For direct drives, bearings shall have an expected life of at least 40,000 running hours. For motors with significant external radial or axial loads, e.g. belt drives, bearing shall have a life of at least 15000 running hours. The bearing assembly shall be provided with a grease relief device to eject any surplus grease in to a separate container.

Lubrication shall be possible without removal of the guarding. All grease nipples, oil cups and dip sticks shall be readily accessible.

#### **24.13 Heat exchangers**

An adequate margin shall be included in the design of heat exchangers to allow for fouling of cooling tubes or ducts under service conditions. Provision shall be made for the easy cleaning of the cooling tubes or ducts, preferably on load.

The cooling tubes or ducts shall be adequately braced and supported to prevent vibration and premature fatigue or fracture.

#### **24.14 Noise level**

Noise levels shall comply with BS 4999, Part-51.

**24.15 Vibration level**

The double amplitude of vibrations as measured at motor bearings shall be within the limits specified in IS 4729, and the limits specified for the driven equipment.

**24.16 Earthing terminals**

Two independent earthing points shall be provided in accordance with IS 3043(1966), on opposite sides of the motor for bolted connection of Employer's earthing conductor.

**24.17 Terminal boxes and associated fittings**

Terminal boxes for motors rated above 110 kW shall be capable of withstanding a system fault level of 31 MVA for 0.12 seconds.

Unless otherwise approved, the terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

415 volt terminals shall be suitable for receiving 1.1 kV grade PVC or XLPE, unarmoured or armoured power cables.

Only three line terminals need be brought out from each three phase primary winding. All inter phase connections whether star or delta shall be made inside the machine.

Marking of all terminals shall be in accordance with IS 4728.

Leads from terminals to the windings shall be adequately sized and braced to withstand heating and forces produced by maximum fault current.

Cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables.

All joints other than those on cable glands shall be gasketed with neoprene, neoprene bonded cork or other approved material.

For single core cables, gland plates shall be effectively non-magnetic.

The following shall be supplied along with each motor :

1. Crimping type tinned copper lugs for power cables, with all necessary hardware.
2. Compression type tinned brass cable glands for power cables (to be supplied loose).
3. Removable type undrilled gland plate.
4. Terminal boxes shall be of weather proof construction with a degree of protection of IP-55. At least one motor of each batch shall be type tested to comply with the following : the terminal boxes shall be subject to an internal air pressure of 0.207 bar g for 12 hours. After this period the pressure shall not be less than 0.104 bar g (after correcting for any change in temperature).

**24.18 Rating plate**

In addition to the requirements as called for in General Technical Clauses and relevant IS, the rating plate shall indicate the following:

- Maximum continuous rating in kW for 70C temperature rise.
- Bearing identification numbers (in case of ball or roller bearings) and recommended lubricant.

**24.19 Paint and finish**

All external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint. Motor colour codes shall comply with the requirements indicated elsewhere in this Specification.

All fasteners used in the construction of the equipment shall be either of corrosion resistant material or electro galvanised to service condition 4. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

## 24.20 Tests

Induction motors shall be subjected to the following routine and type tests.

### 24.20.1 Routine Tests

Visual Checks of the following:

- Marking on rating plates
- Appearance and painting
- Location and details of terminal boxes and accessories.
- In order to observe compliance to degree of protection, following test will be performed. It shall not be possible to insert a feeler gauge of 1 mm thick in the enclosure or flange faces.

Dimensional checks

Measurement of Insulation Resistance (IR) of windings, and space heaters.

Measurement of winding resistance, and space heater resistance at ambient temperature.

High voltage test on main windings, and space heaters.

IR measurement after HV test in main windings, and space heaters.

No load running test (reading of current, voltage input and speed measurement).

Measurement of bearing temperature during steady state conditions.

Vibration measurement at rated speed and rated voltage, also measurement of vibration during coasting down.

Reduced voltage running test at no load

Locked rotor test.

Phase sequence polarity check and check for terminal markings.

Over speed test

Measurement of air gap

Functional check on auxiliaries

### 24.20.2 Type Tests

All tests as listed under routine tests

Measurement of noise at no load

Locked rotor test - measurement of VA power input

Momentary overload test

Temperature rise test at rated conditions as well as at maximum input conditions (during heat run test, measurement of bearing temperature, winding temperature, core temperature, coolant flow and coolant temperature). In case the temperature rise test is carried at other load than rated load, specified approval for the test method and procedure shall be obtained from the Project Manager.

Degree of protection test for the enclosure followed by IR, HV and no load run test.

Terminal box - fault level withstand test and pressure test.

Pull out torque measurement

Measurement of no-load starting time.

#### 24.20.3 DC motors

DC motors shall be subjected to all routine and type tests as per IS 4722. In addition, following tests shall be carried out:

- Noise level measurement as type test.
- Vibration measurement as routine test
- Degree of protection test as per IS 4691 as type test.

#### 24.21 Junction boxes and cables

Design and selection of all the components shall be made with a good margin of safety factor.

The equipment shall be installed indoor.

The reference ambient temperature outside the equipment shall be taken as 50C and relative humidity as 100%.

### 25.0 JUNCTION BOXES

#### 25.1 Construction

Bidder shall supply and install junction boxes complete with terminals as required.

Junction boxes shall be suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, cable-glands, screws and all other accessories required for the erection shall be included in the Bidders scope.

Junction boxes shall be of square or rectangular type of 2.0 mm CRCA sheet steel and shall have bolted cover with good quality gasket lining.

Junction box and covers shall be hot dip galvanised.

All the terminals blocks of ESSEN make or equivalent shall be rated for 1100V and shall be of stud type. Each terminal shall be suitable for connecting two 2.5 mm<sup>2</sup> copper conductor.

All terminals shall be complete with insulated barriers, terminals studs, washers, nuts, locknuts, identification strips etc.

Junction boxes located inside shall have IP-54 protection as per IS 2147. Junction boxes located outside shall have IP-55 protection as per IS 2147.

Junction boxes shall be provided with one earthing terminal suitable for galvanised steel conductor.

The general arrangement, cross sectional details and other technical details are to be submitted in the form of drawing for Project Manager's approval.

#### 25.2 Interconnecting cables

All cables between junction box and field devices shall be stranded copper conductor, PVC insulated, extruded PVC inner sheathed, single galvanised steel wire armoured and overall PVC sheathed 1.1 kV grade and shall conform to IS 1554. The minimum size of cable used shall be 2.5 mm<sup>2</sup> copper conductor. All cables shall be supplied by the Contractor.

### 26.0 CONDUIT AND CONDUIT ACCESSORIES

The bidder shall supply and install all rigid steel conduit, flexible conduits, Hume pipes etc. complete with accessories such as tees, bends, adaptors and couplings as required for cabling work between various field devices to junction boxes.

**Bharat Heavy Electricals Limited**

**Project: 400/220 kV GIS SUB STATION AT ERSAMA, PARADEEP, ODISHA**

**Technical Specification: 38/66kV XLPE cable & accessories**

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### ANNEXURE-A: Compliance Certificate of Technical Specification

The bidder shall confirm compliance to the following by signing and stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation(s) with respect to specification other than those furnished in the schedule of deviations.
3. Only those technical submittals which are specifically asked for in Notice Inviting Tender (NIT) to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of technical offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature

## Bharat Heavy Electricals Limited

Project: 400/220 kV GIS SUB STATION AT ERSAMA, PARADEEP, ODISHA

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### ANNEXURE-B: Deviation(s) of Technical Specification

Bidder shall list out all technical potential deviation/ change request (s) along with clause with respect to technical specifications.

Sl. No.	Page No.	Clause No.	Deviation	Reason/ Justification(s)
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Bidder's Stamp & Signature

# HSE CONDITIONS


at a **GLANCE** (for bidders)

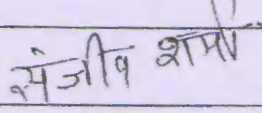
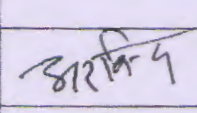
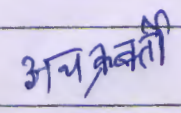


Health Safety and Environment Management



Transmission Business Group, Noida

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Signature			
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**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION BUSINESS GROUP**



## Transmission Business Group

HSE Department, HQ, Noida

Doc No. TBG/HSE/NIT-01

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Date: 22.10.21

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BHEL TBG through its long experience and policy, has developed a culture to consider wellbeing of the society, protection of environment and occupational health and safety of its workers first. TBG has also a culture of transparency in all its business activities. In line to this culture, this NIT annexure is prepared as a peeping window in to the TBG HSE requirements which need to be 100% complied by the successful bidders while executing the contract. Interested bidders should go through these HSE conditions:

### 1. BHEL HSE Policy




In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, contractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

June 5, 2018

Atul Sobti  
Chairman & Managing Director

Creating  of tomorrow

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## 2. Legal Compliances:

- a. Statutory Provisions:** All the sub-contractors are to comply with client specific rules and procedures, the National legislations and codes, in particular the following or their revised versions:

Srl. No	Acts/Rules Name	Srl. No	Acts/Rules Name
1	The Factories Act 1948, Amendment Act 1947	11	Contractor labour Act, 1970 (Regulation and abolition)
2	The Environment Act 1986	12	Provident fund Act, 1952
3	Workmen's Compensation Act, 1923	13	Payment of gratuity Act, 1972
4	Building and Other Construction Workers (Regulation of employment and condition of service) Act, 1996	14	Indian Explosives Act and the explosives Rules 2008
5	Buildings and Other Construction Workers Welfare Act, 1996	15	The Gas Cylinder Rules, 2016, Static and Mobile Pressure Vessels (Unfired) Rules 2016
6	Payment of wages Act, 2017 Equal remuneration Act,	16	The Indian Electricity Act 2003 and Indian Electricity Rules 2005
7	Minimum wages Act.1948	17	The Atomic Energy Act, 2015
8	Employers liability Act, 1938	18	The atomic energy (Radiation Protection) Rules. 2004
9	Industrial dispute Act, 1947	19	National Fire Protection Association (NFPA),
10	maternity benefit amendment act 2017	20	National Building Code of India 2016 etc.

### **b. Indian Standard (IS) Codes related to HSE**

All the sub-contractors are to comply with client specific rules and procedures, the National legislations and codes in particular the following or their revised versions:

Srl	IS Code	Applies on
1	IS: 4081 -1986	Safety code for Blasting and Related Drilling operations
2	IS: 3764 -1992	Safety code for excavation work
3	IS: 5121 -1969	Safety code for pilling and other deep foundations

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4	IS: 2750 -1964	Specification for steel scaffoldings
5	IS: 3696 (Part-I)-1987	Safety code for scaffolds and Ladders: Part- I Scaffolds
6	IS: 3696 (Part-II) -1991	Safety code for scaffolds and Ladders: Part –II Ladders
7	IS: 4082 -1977	Recommendations on stacking and storage of construction materials at site (First revision)
8	IS: 4130-1976	Safety code for demolition of building (First revision)
9	IS: 4912-1978	Safety requirements for floor and wall openings, railings and toe boards (First revision)
10	IS: 5916- 1970	Safety code for constructions involving use of hot bituminous materials
11	IS: 7205 -1974	Safety code for erection of structural steel work
12	IS: 7969 -1975	Safety code for handling and storage of building materials
13	IS: 8989 -1978	Safety code for erection of concrete framed structures
14	IS: 7293 -1974	Safety code for working with construction machinery
15	IS: 2212 -1991	Pipe lines –Identification –Colour code
16	IS: 5216 -1982	Recommendations on safety procedures & practices in Electrical works (Part -I &II)
17	IS: 875 -1964	Code of practice for structural safety of buildings and loading standards
18	IS: 10386 -1983	General aspects Part-1 -1983, Part-2 -1982, Part-6 -1983, Part-10 -1983- Amenities, Protective clothing and equipment, construction, storage, handling, detection and Safety measures for gases, chemicals and flammable liquids
19	IS: 10500-2012	Drinking water (Specification)
20	IS: 10291 -1982	Code of dress in civil engineering works
21	IS: 2925-1984	Safety helmets
22	IS: 1179-1967	Welding helmets
23	IS: 7524 -1979 (Part-I)	Safety goggles
24	IS: 9167 -1979	Ear muff /Ear plugs
25	IS: 6994 -1973 (Part-I)	Canvas hand gloves, Cotton hand gloves, Chrome leather gloves
26	IS: 4770 -1991	Rubber hand gloves tested for 15,000 volts
27	IS: 3521 -1999	Full body safety harness
28	IS: 11057 -1984	Specification for Industrial safety nets
29	IS: 13415 -1992	Protective Barriers in & around buildings (Code of safety)

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30	IS: 13416 -1992	Preventive measures against Hazards at work places-Recommendations part-I Falling materials hazards Prevention part-I
31	IS: 13416 -1992	Preventive measures against Hazards at work places-Recommendations part-II Fall Prevention
32	IS: 15298 -2011 (Part 1&2)	Personal Protective Equipment -Safety shoes
33	IS: 12254 -1993	Poly vinyl chloride (PVC) industrial boots
34	IS: 5557:2004	Industrial and Protective Rubber knee and Ankle boots
35	IS: 2878 -2004	Co2 Type fire extinguisher
36	IS: 2171 -1999	Dry chemical powder fire extinguisher
37	IS: 13849 – 1993	Fire extinguisher for ABC fires
38	IS: 10204-2001	Mechanical Foam type extinguisher (Foam used shall conform to IS: 4989 -1974 and Co2 cartridge shall conform to IS: 4947 -1985)
39	IS: 3786 -1983	Methods for computation of Frequency rate and Severity rates for Industrial injuries and classification of Industrial accidents (First revision)

#### c. The Sub-contractors need to

- Attend HSE familiarization program at TBG-HQ with his site management team. This will be a half day long awareness session on HSE requirements and compliances which the agency is supposed to fulfil during contract execution at site. The session shall be taken by TBG HSE department on intimation by TBSM.
- Request for issuance of Form-V in their name from customer on behalf of BHEL
- Get the Labour license registration from concerned Labour office.
- Get the BOCW Registration done along with the labour license.
- Get their labourers registered under BOCW for benefits provided by the office.
- Maintain Seven registers of labours as per BOCW requirement.
- Ensure payment of wages to labours not less than the current minimum wages applicable in the premises.
- Ensure PF deduction of labourers and submission of proof to BHEL office (Wage sheet, ECR & Challan copies) duly signed.
- Submit Labour Payment Certificate by 10th of Every month.
- File timely returns, get renewals done and submit a copy to BHEL office.

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- Get Workmen's Compensation policy before the start of work, covering all the labourers and staff,
  - Policy should clearly mention the project name and location,
  - should be as per labour class and wage.
  - Should cover all the height workers with clear mention of Max. height.
  - Policy should be submitted to BHEL office and renewal before expiry.
- Issue employment card to every worker.

### 3. Labour Welfare and Medical Facilities

#### a. Labour Welfare

1. Declaration of normal working hours and weekly off day, Payment day & intervals
2. Paid rest days & holidays.
3. Payment of overtime @ twice the normal wage rate.
4. No labour shall be allowed overtime >12 hrs/week, limited to 48 hrs/month.
5. Rest and lunch area.
6. Separate Male/Female Toilets and Lavatories, clearly marked in local Language and provided with signage.
7. Cold and clean drinking water facility suitable to strength and near workplace
8. Creche for children of female workers as per BOCW requirements
9. Arranging labour accommodation in hygienic environment with the facilities of Water (Drinking, Sanitation), washing and bathing area, toilets in sufficient nos., clean and safe camps and surrounding, access road, well illuminated camp and roads, mode of contact, transport facility, first aid centre, 24x7 Security etc.
10. Cooking and eating place to be maintained in hygienic condition
11. General awareness of health and hygiene.

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#### b. Medical facilities and Health centres

- Availability of first aid box at every work location and agency office, with contents as per BOCW requirement.
- Emergency vehicle (four wheeler) at work place
- Availability of stretchers in emergency vehicle and in office.
- Trained first aider
- Medical check-up for all the supervisors and workers including cooks, at the time of induction and annually thereafter.
- Tetanus Vaccination for all in every six months.
- Identification and tie-up with nearby reputed hospital(s) and display of their contact number in Emergency contact list.


## 4. House Keeping & Storage

Housekeeping is a continuous process and is the part of work. Agencies shall maintain safe and presentable housekeeping all the time in their respective areas, common work locations and passage areas. Roads, passages, staircases, entrance/exit gates shall always be maintained obstruction free. No material shall be left or stacked at the roof edges. Agency shall make arrangements to remove scraps on regular basis and dispose them at a space provided by customer, clearly fenced and marked by the sub-contractor as **"SCRAP YARD"**. Suitable arrangement like dedicated housekeeping team and tractor/hydra should be identified for this work.

Construction materials like shuttering materials, staging materials, cables, re-bars, cements bags, earthing flats and rods, FF pipes, surplus soil etc should be stored/stacked properly such that it should neither pose threat to safety of man nor should obstruct the free movement of man and machineries.

Every sub-contractor should have separate and well maintained storage area for his own materials, T&Ps, PPEs and BHEL issued materials. Consumables like diesel, cotton, grease, oil, paint, admixtures and other fire potential materials should be stored separately with suitable firefighting facility.

Fire capacity of store area to be assessed and accordingly fire extinguishers shall be planned suiting the class and capacity of fire. Sand heaps may also be stacked in open store yards suitably to use in case of fires.

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## 5. Site Safety

### a. Induction and others safety trainings

Every sub-contractor shall make arrangement to provide induction training as per BHEL and/or customer requirement on a pre-approved and fixed module to all its new inductees irrespective of class or grade of appointment/hire. He shall also arrange the required facilities for induction training such as board, marker, dummy, posters/banners with all the mandatory PPEs.

Sub-contractor shall also arrange for periodic trainings on fire-fighting, first aid, CPR, importance and use of PPEs, electrical safety, hot work safety, Height work safety, confined space, deep excavations and barricading, concreting work safety etc.

### b. Appointment of Safety Officer/Supervisor

Every sub-contractor shall appoint at least one full time qualified safety officer having qualification and experience as specified in Schedule-VIII of BOCW Act-1996. He shall not be assigned any duty/work other than assisting in upliftment of safety practices. He shall perform his duties in accordance with the requirements of Schedule-VIII of BOCW-1996. He shall ensure daily TBT, induction training, health check-up and other such compliances as per HSEP-14 on regular basis. In case of non-appointment, agency shall be penalized as per provisions in clause no. 7.0 of HSEP-14 (HSE Plan for Site Operations (subcontractors))

### c. Safety organisation, Safety committees and meetings

Safety officer shall report directly to the head of the projects of the sub-contractor management. There shall be some appointed or nominated safety stewards from each sub-group like shuttering, bar-bending, concreting, brick work, material handling, structure erection, cable laying, pipe work, maintenance, batching plant, housekeeping etc.

A safety committee shall be formed including members from different agencies, BHEL and customer covering at-least 50% participation from workers. Safety committee shall meet on weekly basis or as may be decided by customer, outcomes shall be complied as committed.

### d. Personal Protective Equipments.

Unless mentioned otherwise, there will be three mandatory PPEs- Safety shoes, Safety Helmet and Reflective jackets conforming to relevant IS codes as mentioned above.

Every person entering in the project premises shall use above mandatory PPEs.

There will be other PPEs too based on the work requirement like:

Twin lanyard full body harness, fall arresters and life lines for height workers,

Face shield for welders and grinders, Induction helmets and Electrical resistant shoes with FRP/PVC toe for electricians and commissioning engineers, Gum boots for concrete workers and manual excavators, Goggle for gas cutters and grinders, Aprons for welders, shoulder pads for material handlers, Hand gloves – Leather for binders/welders/grinders, certified Rubber gloves

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for electricians, PVC for concrete/cement handlers, cotton-housekeeping team/brick coolies/erectors, cable laying men and other material handlers. Dust mask for cement handlers.

#### e. Material Handling

BHEL as a policy discourages continuous manual handling. Material handling contributes a major portion in the project and hence proper means (mechanical/ electrical powered) should be deployed appropriately for this work. Cranes/Faranas/hydras should not be used for material transportation for long distances(>100m), if such movement is un-avoidable, it must be accompanied by a trained signal man. Long materials should be guided by tagline. Roads for material movement should be free from obstructions. Lifting appliances must be in good condition and must have test/inspection certificates.

Lifting tackles like- D-shackles, chains, ropes, slings, belts shall be periodically inspected and shall have valid test certificate and/or third party inspection certificates.

Painted/galvanized structures/materials to be lifted by adequate capacity nylon belts only.

If a machine undergoes a major maintenance, fresh TPI shall be required before use.

Hydraulic/pneumatic machines shall be free from leakages. Daily checklist to be filled and witnessed by the concerned supervisor before start of the work.

#### f. Vehicle/Machinery Documents and other safety requirements

- **Crawler mounted boom cranes/Tyre mounted telescopic cranes/tower cranes**
  1. Valid third party inspection certificate.
  2. Valid Insurance policy
  3. Registration Certificate (if applicable)
  4. Valid Pollution under control (PUC) (if applicable)
  5. Fitness certificate from RTO (if applicable)
  6. Operator's valid license, experience and/or competence certificate.
  7. Swing horn
  8. Reverse horn
  9. Boom aviation light
  10. Approved Load chart (inside cabin)
  11. Fire extinguisher (inside cabin)
  12. First aid kit (inside cabin)
  13. Boom angle indicator
  14. Hook Latch
  15. Reflector strips on around cabin and on boom
- **Loader backhoe (JCB), crawler excavators (Poclain), Hydra,**
  1. Valid third party inspection certificate.
  2. Valid Insurance policy
  3. Registration Certificate (if applicable)
  4. Valid Pollution under control (PUC) (if applicable)

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5. Fitness certificate from RTO (if applicable)
6. Operator's valid commercial license, experience and/or competence certificate.
7. Reverse horn
8. Approved Load chart (inside cabin) (Hydra)
9. Fire extinguisher (inside cabin)
10. First aid kit (inside cabin)
11. Hook Latch (Hydra)
12. Reflector strips on around cabin and on boom

- **Tipper, Transit mixtures (TM), Self-loading concrete mixture (Ajax Fiori), Tractors**

1. Valid third party inspection certificate.
2. Valid Insurance policy
3. Registration Certificate
4. Valid Pollution under control (PUC)
5. Fitness certificate from RTO
6. Operator's valid commercial Heavy license, experience and/or competence certificate.
7. Reverse horn
8. Fire extinguisher (inside cabin)
9. First aid kit (inside cabin)
10. Reflector strips on around cabin and on body

**Note: 1. Tractors may be allowed with Light Commercial/non-commercial license on customer's consent.**

- **Cars, Taxis, scooters, motor cycles and other public carriers**

- Valid 2/4 wheeler license (as applicable- commercial/non-commercial)
- Registration Challan
- Valid Insurance
- Pollution under control

**g. Man-lifts (Cherry pickers), Scissors Lifts**

1. Trained operator with experience/competence certificate and license
2. Valid third party inspection certificate.
3. Valid Insurance policy
4. Registration Certificate (if applicable)
5. Valid Pollution under control (PUC) (if applicable)
6. Swing horn
7. Reverse horn
8. Boom aviation light
9. Fire extinguisher (inside cabin)
10. First aid kit (inside cabin)
11. Reflector strips on around cabin and on boom

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**Note:**

1. No one shall ride man-lift bucket without safety belt, safety shoes, helmet and reflective jacket.
2. Not more than 3 persons at a time will board in bucket of man-lift (without any heavy materials) including operator.
3. Operator will not leave the machine while persons are elevated and working.
4. No one other than the authorised operator will operate the man lifts/Scissors lifts.

**h. Excavation**

Prior permission/clearance from customer is a must for excavations in areas where underground service services such as gas/water/oil/chemical/electrical lines may be routed. Due precautions shall be taken during excavation in such area. Excavations near water bodies (ponds/canals etc.) shall be done with sand/soil bags ready to plug water from accidental damaged/burst of edges. All the excavations shall be done by either step cutting (min. 600mm step at every 1.5m depth) or slope cutting at 1:2(X:Y axis) (or greater depending upon the soil condition). Where step cutting/slope cutting is not possible due to space constraints, shoring/shuttering or sheet piling to be used to check collapse of soil.

Excavated soil shall be stacked away from edge of the pit, at-least 1.5 meters or half of the depth whichever is higher. Height of the stack shall not exceed 2m in height.

Ramps shall be provided for access of the workers in large pits and ladder of metal/good built for small pits. Ladders shall be of sufficient length protruding at least 1m above the ground level.


Pumps of adequate capacity shall be available for pumping out of water. No lone worker shall be allowed to work in any excavation. Overloaded vehicle shall not be allowed near excavated pits.

**i. Bar bending and Binding**

Bar bending machine shall be installed under shed/roof. It shall be properly earthed and maintained for operation. Housekeeping of the area shall be team's responsibility on daily basis. All be bar benders shall be given hand gloves (leather/cotton) in addition to mandatory PPEs. Scrap shall be segregated and moved to scrap yard on regular basis. Bar bending station shall be located away from Main plying roads/passages. The station shall be well illuminated, shall have a maintained first aid kit and potable water. Station shall be located in such a way that the movement of the material be minimised.

**j. Concreting**

**No electric vibrators** shall be allowed to use. All the concrete workers shall be issued gum boots, safety helmets, reflective jackets and PVC hand gloves. Free fall of concrete from chute shall not exceed 1m in height. Heavy machineries/ vehicles shall be kept at least 2m away from the edge. Emergency vehicle shall be available near concreting work. Late night works shall be avoided, if it is unavoidable, a prior permission from BHEL/Customer is mandatory.

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#### k. Welding, Gas Cutting & other hot works

**Welding:** Only experienced welders should be deployed for welding jobs. Welders shall be provided with apron, hand gloves, arm pads, leg pads, face shield and safety shoes. Welding leads shall be joint less and insulated. Power input point shall be fully covered at machine.

**Gas cutting:** If LPG is being used, domestic cylinder is strictly prohibited inside the project premises, (not allowed for site kitchen too). Hose pipes shall be in good condition without cracks, cuts, punctures or joints. Ends should be clamped with worm clamps. Dial gauges shall be of good quality and duly calibrated. Flash back arresters is a must for both oxygen/acetylene or LPG/Oxygen combination. Cylinders shall be stored, transported and used in vertical position only. When not in use, they shall be capped. Empty and filled cylinders to be stored separately with distinct marking.

Cylinders shall neither be rolled on the ground nor thrown during loading/unloading.

**Grinding:** Grinder shall be given clear glass face shield, apron, safety shoes, ear muffs and hand gloves. Grinder machines shall have wheel guard. Plug tops to be used for power connection preferably three wire type. Only trained persons shall be allowed to use grinders, abrasive cutters. Electrical connection shall be free from cuts, joints etc.

#### l. Erection & Height Work

Only trained fitters and experienced helpers shall be engaged in erection work. Step bolts of lattice towers shall be checked for full tightness with spring washers before use. Height pass shall be issued to the identified group of erectors who have passed medical test and have working experience at height. Name of such workers shall be displayed at appropriate place. These workers only shall be allowed to work at height. Height work shall not be permitted in high wind/bad weather condition, during raining or in night/dark.

#### m. Electrical Safety

BHEL usually provided single point power source and sub-contractors draw power from there. Otherwise agencies make their own arrangement for construction power like DG sets etc. Sub-contractors shall submit their load requirement (amperage & phase) to BHEL before start of work. Accordingly, they shall make arrangements to draw power and distribution arrangements too in a safe way. MCCBs and HRC fuses to be put in circuit for short circuit and overload protections and RCCBs of 30mA sensitivity to be put at each distribution panel for human safety. Earthing pits shall be installed at each distribution point and maintained below three Ohm resistivity which shall be inspected randomly. The distribution points shall be clean, free from vegetation and water logging, easily accessible and covered/protected from three sides and top for rain. Earthing of DBs shall be done by 25x3mm GI flats connected from proper earth pits. Insulation mat, PVC Sheet/Wooden plank to be placed before DBs as platform. DB Sheds shall be legibly marked with name of agency, contact no of electrician and SLD of that DB. Only industrial plugs and sockets shall be allowed. Three wire (Phase, neutral and earth) system shall be used for tools, lights and machineries and two wire power draw shall be strictly prohibited. PTW and LOTO system shall be maintained to work on LT system. Name and contact no of authorised electricians who will be responsible of electrical power facility maintenance shall be submitted to BHEL by Agencies. Unauthorised sharing of power from one agency to other is strictly prohibited. Electricians shall use standard PPEs and insulated tools only. Standard and tested/certified discharge rods to be used in the areas where there is a possibility

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of residual current or induction charge. The induction rod to be connected to the earth first and removed in the last. Induction helmets only to be used in the charged area. Electricians to be provided with electrical resistant safety shoes having FRP/PVC toe.

#### **n. Dust Gases and fumes**

Sub-contractor shall make arrangements to avoid accumulation of dust fumes and gases. Cement handlers inside store or at batching plant and gravel spreader shall be given effective nose masks and jaggery (at least 200g per person per day). DG sets and other machineries like cranes excavators etc. shall have valid and effective PUC certificate and shall have maintained engine with silencer. No IC engine operated machine shall be used in confined and covered area like hall, sheds, store etc. where accumulation due to lack of ventilation can increase to harmful levels. Dedicated arrangements (tanker or tractor with sprinkler) shall be made by the sub-contractors (individual or jointly) to continuously subside the dusts arising out of the movement of the vehicles roads/passages. Welding activities near roof accumulates harmful gases. Welders in such positions shall be provided with effective masks conforming to IS standards.

#### **o. Vehicular Traffic**

Speed limits defined within the premises shall strictly be followed by the drivers/commuters of construction as well as other vehicles.

Every construction machinery, man-lift shall display the name, contact no and passport size photograph of the authorised operator (There can be one or more authorised operators).

No one other than operator and co-operator shall sit inside the cabin of any construction machine while it is working.

Construction machineries (tractor, trucks, tippers, JCBs, hydra, Fassi cranes etc. shall never be used as mode of public transport. Machineries like Ajax Fiori and hydra shall not be driven in back direction except for small distances. No overloaded vehicle shall be permitted entry in the project premises.

Over speeding shall be reported and driver/operator shall be barred from entry or shall be penalised.

Drunken drivers shall be barred from entry in the project.

Carrying harmful weapons like knives (>6"), guns etc. shall permanently disqualify the person from entry in project premises.

#### **p. Barricading and floor openings**

Every pit deeper than 4 feet (1.2m) shall be barricaded immediately after excavation and will remain barricaded till backfilling.

Pits/trenches drains near roads, passages whether temporary or permanent shall be hard barricaded and well illuminated. Roof edges and openings shall be strictly hard barricaded and illuminated. Height works like masonry works, structure erection, erection by cranes, Lattice tower/beam erection areas shall be barricaded to restrict entry. Areas under charging/commissioning shall be barricaded and caution boards shall be displayed on newly charged areas.

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#### q. Scaffold & Ladder

**No bamboo/wooden scaffold** shall be allowed to be used. Only tubular steel scaffolds with couplers conforming to the relevant IS codes shall be allowed with base plates. Standard steel or wooden planks to be used as platforms and no packing materials shall be used. All the platforms shall be built with provisions of **top rail at 1m height, mid rail at 0.5m height and toe boards of min 6" height** at floor level. Minimum width of platform shall be 900mm and if wheel barrow is to be used then 1200mm. Means of access to be provided in the form of ladders, ramps or staircase. Multilevel work platforms or those platforms having passage underneath shall be provided with safety net, screen or canopy at each level for protection from falling objects. Platforms shall be free from concrete, debris or other materials. Platforms shall not extend out of the putlogs and shall be secured and fastened. Decking shall be made non-skidding.

Scaffolds under erection shall be tagged **"RED"**, under repair/maintenance/inspection shall be tagged **"YELLOW"** and ready for use shall be tagged **"GREEN"**

Only metal ladders in the construction site and FRP ladders in charged areas shall be allowed. Ladders made from packing materials shall not be used. Ladders shall be securely fixed at bottom, top and long ladders at middle points too at an interval not more than 2400mm and must have a landing at every 6m. Inclination angle should be approximately 1:4 (X:Y) or 75deg. Ladder must extend at least 1m above the platform/access area. Gap between two rungs shall not exceed 300mm. Portable ladder should not be more than 4m in length. Minimum width of the ladder shall not be less than 300mm.

Use of Mobile aluminium scaffold is preferably advisable for erection of transformers/reactors.

#### r. Illumination


The sub-contractor shall ensure that the areas such as work stations, buildings, batching plants, passages/roads, stores, rest areas, power sources, staircases etc. are illuminated sufficiently to make safe work conditions at site and shall not be less than the relevant IS standards. Excavations/ below ground level structures near passages/roads shall also be sufficiently illuminated.

#### s. Safety banners/posters, caution boards

Sub-contractors shall display boards and banners in sufficient quantity having safety signs, slogans, important messages, pictures, cautions at prominent locations to promote safety and spread awareness for important precautions such as "Deep Excavation Ahead", "Speed Limit", "Charged Area", "Do not operate", "Hard hat area", "No smoking Zone" etc. Boards containing messages of Emergency contacts, First aid facility, rates of minimum wages, working hours, rest day etc. should be displayed at specific areas.

#### t. Waste management and disposal

Sub-contractor shall make suitable and effective arrangement to remove waste material from site on regular basis and store them in an identified and safe location. Disposal of wastes shall also be done as per manufacturer's instructions or as per the guidelines laid by legal authorities. Re-bars, Cement bags, packing material (wooden/metal/plastic/paper), paint, oil, grease, cables (armour, sheathing, insulation), civil debris, metal chips, GI sheet scraps, batteries etc. are the common waste materials. Sub-contractor

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shall arrange disposal of the hazardous wastes/materials in conformance to the legal and contractual requirements only.

#### **u. Inspection of PPEs, T&Ps, Machineries and lifting appliances**

All the PPEs, T&P and lifting appliances purchased newly by sub-contractors shall have test certificates which shall be submitted to BHEL office periodically or on demand. There shall be at least monthly joint inspection schedule for inspection of healthiness of all the PPEs, T&Ps and lifting appliances. All the lifting appliances shall be tested and examined by a competent person before taking into use for the first time or after it has undergone any alterations or repairs liable to affect its strength or stability

and also once at least in every twelve months. To confirm quality of the PPEs as per the relevant IS codes, BHEL may ask sub-contractors to get any or all types of PPEs tested through NABL approved lab as per relevant IS codes. At any stage, the 100% cost of such tests shall be in the scope of respective sub-contractors.

#### **v. Cable Laying**


Sub-contractor shall ensure cable trenches free from water, mud, debris, snakes, Scorpios, lizards before start of the work in trenches. Cable drum rollers shall be used to pull cables out of drums to avoid twisting of cables. Hand gloves, Safety shoes/gum boots, reflective jackets, safety helmets shall be provided to the workers. Cable laying area shall be well illuminated.

#### **w. Fire Protection**

Every sub-contractor has to maintain their working area, store and office area free from bushes. Stacking of flammable materials like wood, paper, plastic, paint, oil, grease, fuel, cotton, gases etc. at isolated place disconnected from other storage and office areas. Adequate arrangements of firefighting means like suitable extinguishers, fire/water buckets, water tanks, sand dunes etc. shall be made by the agency depending upon the fire capacity assessed or as per MSDS. Fire drills and trainings on how to operate fire extinguishers and how to react in case of fire breakouts shall be the part of regular training program. Guards and store persons must be a regular participant of such training programs. A list of trained firefighting persons and periodicity of such training programs shall be submitted to BHEL by every agency and same to be adhered. Sufficient number of fire extinguishers with suitable class shall be placed at such locations where there can be fire hazard like stores, pantry, office, DG set, electrical distribution panels etc.

#### **x. Fencing of exposed rotating parts**

Exposed rotating parts poses great threat to the person in vicinity. Such parts need to be fenced/covered. Guards are mandatory of grinders, abrasive cutters. Flywheels of the engines of heavy machines, Diesel engines, DG sets need to be covered. Electric winch machines, pulleys, chains, shafts, exhaust fans at reachable height, table fans, need to be caged/fenced. Such fencing/guard shall not be removed while machinery is in operation.

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#### **y. Emergency preparedness response plan and periodic mock drills.**

Sub-contractor shall comply JSA (Job Safety Analysis) and arrange to mitigate the effects of identified possible hazards. He shall also define following in response to emergency preparedness:

An emergency assembly point and put a board of the same with information to all in induction training.

Have facility of ambulance or tie-up with nearest hospital for service in minimum possible time (Max-30min) if there is not ambulance inside the premises.

Ensure availability of emergency vehicle with driver all the time at site during work.

Conduct mock-drills on possible risks like electrocution, fall from height, fire, heat stroke etc., record responses and take photographs to submit in BHEL office. Stretchers availability in emergency vehicle or at work place should be well accessible. Provide fire extinguishers of right type at right place in right quantity with information to all. Display emergency contact nos. to various risk locations and at office, service building or at major work locations. Provide first aid training by doctors for and display names of such trained first aiders and fire fighters. Rescue kit with trained staff or man lift or both to rescue a man hanging by safety belt at height. Provide running water tap near chemical storage and handling points. Agencies shall follow emergency response plan prepared by BHEL in each area of work, store and office.

#### **z. Safety reports & Reporting of accidents**

BHEL will provide "formats and checklists" for the purpose of records/documents pertaining to the compliance of aforesaid clauses. Agencies shall be responsible for strict adherence and compliance for timely generation and fill-up of the checklists and reports. These shall be submitted on weekly and monthly basis as specified in the formats.

Agency shall also promote such an environment that the near misses, incidents and accidents are reported by every person, whosoever witnesses them. These shall help in analysing the trend and taking measures in reducing/stopping the accidents/incidents. Initial reporting can be in any form-by call, SMS, WhatsApp, e-mail, letter etc.

Major and fatal accidents or high potential incidents shall be investigated for root cause and outcomes shall be immediately implemented to check recurrences.

## **6. General conditions and penalty clauses**

Following are the general conditions:

PPEs shall not only bear the ISI mark but also be conforming to the required standards, 100% compliance of the PPEs is mandatory.

Over speeding of vehicles shall attract penalty/notice and recurrence will attract debarring from entry into project premises.

Hiding of facts like incidents, accidents, fake/forged reports/certificates shall also attract penalty/ notice or both. Only approved third party agencies shall be allowed to inspect the machines, T&Ps. Reports shall directly be sent to BHEL/customers by the third parties.

Insurance and TPIs to be renewed before expiry. Machines, T&Ps shall not be allowed to work if renewal delayed. Continuity of WC policy to be maintained religiously by the respective agencies.

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Agency shall submit the status report of his labour license, BOCW registration, WC Policy, insurance & TPI validity on monthly basis with list of machineries and T&Ps

Sub-contractors shall also maintain a buffer stock of all the PPEs in at least 20% excess to the present strength of the work force.

If construction power is not drawn as per the guidelines laid in clause no. 5(m), given above, BHEL may take-up this work at the risk and cost of the agency and/or may withhold a sum of min. Rs. 50,000/- (Rs. Fifty Thousand) or more as the site in-charge deems fit till the system is aligned as per aforesaid requirement.

Agencies shall be responsible for the compliance of the above requirements. Failure in one or more clauses/area shall attract a notice or monitory penalty or a combination of above.

Monitory penalty will be

- Rs. 1000/- per person/incident per day for non-conformity in above areas.
- A Major/severe accident shall attract a penalty of Rs. 2,00,000/- per head
- Fatality or permanent disability with total loss of earning capacity, if any, will attract a penalty of Rs. 5,00,000/- (Rs. Five Lakh).
- Further fatality/permanent disability shall attract double the last penalty imposed on the agency.
- Above penalties are exclusive of medical expenses of the victim or compensation to the family through insurance policy (WC Policy or group insurance).
- **Penalties imposed by customer shall be fully transferable to the sub-contractor. In the event of above cases, penalties shall be imposed whichever will be higher.**
- Evaluation of agency's performance on HSE compliance shall be done as per BHEL guide lines/system.

### Revision History

Revision Date	Revision No.	Old Text	New Text	Reason	Revised by (with sign)
03.05.2019	00	N/A	Full Document	New Release	
12.10.2021	01	Nil	Attend HSE familiarization program at TBG-HQ with his site management team. This will be a half day long awareness session on HSE requirements and compliances which the agency is supposed to fulfil during contract execution at site. The session shall be taken by TBG HSE department on intimation by TBSM. (at page no. 4)	For better understanding of HSE requirements to agency. (HSE Review meeting dated 23.08.2021)	
12.10.2021	01	Edition	Inclusion of penalty provisions in case of non-deployment of safety person(page-7)	Introduction of HSEP-14	

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