TRANSMISSION SERVICE AGREEMENT

FOR

DEVELOPMENT AND OPERATION OF INTRA-STATE TRANSMISSION SYSTEM

FOR TRANSMISSION OF ELECTRICITY THROUGH TARIFF BASED COMPETITIVE BIDDING FOR

EVACUATION SCHEME FOR 2000MW SOLAR PARK AT RYAPTE VILLAGE, TUMKUR DISTRICT

BETWEEN THE

POWER COMPANY OF KARNATAKA LIMITED (PCKL)

(Nodal Agency)

AND

RYAPTE POWER TRANSMISSION LIMITED

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THIS TRANSMISISON SERVICE AGREEMENT (hereinafter referred to as “TSA” or “Agreement” or "the Agreement" or “this Agreement") is made on the ……. [Insert day] of……. [Insert month] of Two Thousand and…… [Insert Year]

BETWEEN:

The ……..[Insert name and registered address of “Nodal Agency” for the project] acting as a Nodal Agency (referred to as the “Nodal Agency”), which expression shall unless repugnant to the context or meaning thereof include its successors, and permitted assigns) as Party of the one part;

AND

……. [Insert Name of the Transmission Service Provider], incorporated under the Companies Act, 1956/ Companies Act, 2013 (as the case may be), having its registered office at …….. (herein after referred to as “Transmission Service Provider” or “TSP” or “InSTS Licensee”, which expression shall unless repugnant to the context or meaning thereof include its successors, and permitted assigns) as Party of the other part;

(“Nodal Agency” and “TSP” are individually referred to as “Party” and collectively as the “Parties”)

AND WHEREAS:

A) In accordance with the Bidding Guidelines, the Bid Process Coordinator (hereinafter referred to as BPC) had initiated a competitive e-reverse bidding process through issue of RFP for selecting a Successful Bidder to build, own, operate and transfer the Project comprising of the Elements mentioned in Schedule 1 (hereinafter referred to as the Project)

B) Pursuant to the said e-reverse bidding process, the BPC has identified the Successful Bidder, who will be responsible to set up the Project on build, own, operate and transfer basis to provide Transmission Service in accordance with the terms of this Agreement and the Transmission License.

C) The Selected Bidder have submitted the Contract Performance Guarantee and acquired one hundred percent (100%) of the equity shareholding of Ryapte Power

Transmission Limited, along with all its related assets and liabilities in terms of the provisions of the Share Purchase Agreement.

D) The TSP has agreed to make an application for a Transmission License to the State Commission for setting up the Project on build, own, operate and transfer basis.

E) The TSP has further agreed to make an application to the State Commission for the adoption of the Transmission Charges under Section 63 of the Electricity Act, 2003, along with a certification from the Bid Evaluation Committee in accordance with the Bidding Guidelines issued by Ministry of Power, Government of India.

F) The TSP agrees to the terms and conditions of this agreement, for making available the InSTS and charge the Transmission Charges in accordance with the terms and conditions of this agreement.

G) The billing, collection and disbursement of the Transmission Charges by the PCKL to the Licensee shall be governed as per this agreement.

H) The terms and conditions stipulated in the Transmission License issued by the State Commission to the TSP shall be applicable to this Agreement and the TSP agrees to comply with these terms and conditions. In case of inconsistency between the Transmission License terms & conditions and the conditions of this Agreement, the conditions stipulated in the Transmission License granted by the State Commission shall prevail.

NOW, THEREFORE, IN CONSIDERATION OF THE PREMISES AND MUTUAL AGREEMENTS, COVENANTS AND CONDITIONS SET FORTH HEREIN, IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES HERETO AS FOLLOWS:

ARTICLE: 1

1 DEFINITIONS AND INTERPRETATIONS

1.1 Definitions:

1.1.1 The words / expressions used in this Agreement, unless as defined below or repugnant to the context, shall have the same meaning as assigned to them by the Electricity Act, 2003 and the rules or regulations framed there under including those issued / framed by the State Commission (as defined hereunder), as amended or re-enacted from time to time or the General Clauses Act, failing which it shall bear its ordinary English meaning.

The words/expressions when used in this Agreement shall have the respective meanings as specified below:

"Acquisition Price" shall have the same meaning as defined in the Share Purchase Agreement;

"Act" or **"Electricity Act"** or **"Electricity Act 2003"** shall mean the Electricity Act, 2003 and any amendments made to the same or any succeeding enactment thereof;

"Affiliate" shall mean a company that either directly or indirectly

i. controls or

ii. is controlled by or

iii. is under common control with

a Bidding Company (in the case of a single company) or a Member (in the case of a Consortium) and "**control**" means ownership by one entity of at least twenty six percent (26%) of the voting rights of the other entity;

"Availability" in relation to the Project or in relation to any Element of the Project, for a given period shall mean the time in hours during that period the Project is capable to transmit electricity at its Rated Voltage and shall be expressed in percentage of total hours in the given period and shall be calculated as per the procedure contained in, Annexure V of Karnataka Electricity Regulatory Commission (Multi Year Transmission, Distribution and Retail Supply Tariff) Regulations, 2024 attached herewith in Schedule 6;

"Bid" shall mean technical bid and financial bid submitted by the Bidder, in response to the RFP, in accordance with the terms and conditions of the RFP;

"Bid Deadline" shall mean the last date and time for submission of the Bid in response to RFP, as specified in the RFP;

"Bidding Company" shall refer to such single company that has made a Response to RFP for the Project;

"Bidding Consortium / Consortium" shall refer to a group of companies that has collectively made a Response to RFP for the Project;

"Bid Documents" or **"Bidding Documents"** shall mean the RFP, along with all attachments thereto or clarifications thereof;

"Bidding Guidelines" shall mean the "Tariff Based Competitive Bidding Guidelines for Transmission Service" and "Guidelines for Encouraging Competition in Development of Transmission Projects" issued by Government of India, Ministry of Power under Section – 63 of the Electricity Act as amended from time to time;

"Bid Process Coordinator" or **"BPC"** shall mean a person or its authorized representative as notified by the Government of Karnataka, responsible for carrying out the process for selection of Bidder who will acquire Transmission Service Provider;

"Business Day" shall mean a day other than Sunday or a statutory holiday, on which the banks remain open for business in the State in which the Nodal Agency's registered office is located and the concerned TSP are located;

"CEA" shall mean the Central Electricity Authority constituted under Section -70 of the Electricity Act;

"Change in law" shall have the meaning ascribed thereto in Article 12;

"Commercial Operation Date" or **"COD"** shall mean the date as per Article 6.2;

"Central Commission" or **"CERC"** shall mean the Central Electricity Regulatory Commission referred to in sub-section (1) of Section 76 of the Electricity Act, 2003 or its successors and assigns;

"Central Government" shall mean the Government of India;

"Competent Court of Law" shall mean the Supreme Court or any High Court, or any tribunal or any similar judicial or quasi-judicial body in India that has jurisdiction to adjudicate upon issues relating to the Project;

"Connection Agreement" shall mean the agreement between the CTU or STU or any other concerned parties and the TSP, setting out the terms relating to the connection of the Project to the Inter connection Facilities and use of the Inter State Transmission System / Intra State Transmission System (as the case may be) as per the provisions of the IEGC/State Grid Code, as the case may be;

"Consultation Period" shall mean the period of sixty (60) days or such longer period as the Parties may agree, commencing from the date of issue of a TSP's Preliminary Notice or a Nodal Agency's Preliminary Termination Notice, as provided in Article 13 of this Agreement, for consultation between the Parties to mitigate the consequence of the relevant event having regard to all the circumstances;

"Consents, Clearances and Permits" shall mean all authorizations, licenses, approvals, registrations, permits, waivers, privileges, acknowledgements, agreements, or concessions required to be obtained from or provided by any concerned authority for the development, execution and operation of Project including without any limitation for the construction, ownership, operation and maintenance of the Transmission Lines and/or sub-stations;

"Construction Period" shall mean the period from (and including) the Effective Date of the Transmission Service Agreement up to (but not including) the COD of the Element of the Project in relation to an Element and up to (but not including) the COD of the Project in relation to the Project;

"Contractors" shall mean the engineering, procurement, construction, operation & maintenance contractors, surveyors, advisors, consultants, designers, suppliers to the TSP and each of their respective sub-contractors (and each of their respective successors and permitted assigns) in their respective capacities as such;

"Contract Performance Guarantee" shall mean the irrevocable unconditional bank guarantee, or insurance surety bond or Payment on Order Instrument submitted and to be submitted by the TSP or by the Selected Bidder on behalf of the TSP to the Nodal Agency from a bank mentioned in Annexure 17 of the RFP, in the form attached here to as Schedule 8 (for bank guarantee) or Schedule 8A (for insurance surety bond issued by any of the insurance companies authorized by Insurance Regulatory and Development Authority of India), or Schedule-8B (for Payment on Order Instrument issued by PFC/REC/IREDA, in accordance with Article 3 of this Agreement and which shall include the additional bank

guarantee or insurance surety bond or Payment on Order Instrument furnished by the TSP under this Agreement;

"Contract Year", for the purpose of payment of Transmission Charges, shall mean the period beginning on the COD, and ending on the immediately succeeding March 31 and thereafter each period of 12 months beginning on April 1 and ending on March 31 provided that the last Contract Year shall end on the last day of the term of the TSA;

"CTU" or **"Central Transmission Utility"** shall have same meaning as defined in the Electricity Act, 2003;

"Day" shall mean a day starting at 0000 hours and ending at 2400 hours;

"D/C" shall mean Double Circuit;

"Dispute" shall mean any dispute or difference of any kind between the Parties, in connection with or arising out of this Agreement including any issue on the interpretation and scope of the terms of this Agreement as provided in Article 16;

"Due Date" in relation to any Invoice shall mean the thirtieth (30th) day after the date on which any Invoice is received and duly acknowledged by the Nodal Agency (or, if that day is not a Business Day, the immediately following Business Day), and by such date, the Invoice is payable by the Nodal Agency;

"Effective Date" for the purposes of this Agreement, shall have the same meaning as per Article 2.1 of this Agreement;

"Electrical Inspector" shall mean a person appointed as such by the State Government under sub-section (1) of Section 162 of the Electricity Act 2003 and also includes Chief Electrical Inspector;

"Electricity Rules 2005" shall mean the rules framed pursuant to the Electricity Act 2003 and as amended from time to time;

"Element" shall mean each Transmission Line or each circuit of the Transmission Lines (where there are more than one circuit) or each bay of Sub-station or switching station or HVDC terminal or inverter station of the Project, including ICTs, Reactors, SVC, FSC, etc. forming part of the InSTS, which will be owned, operated and maintained by the concerned Licensee, and which has a separate Scheduled COD as per Schedule 2 of this Agreement and has a separate percentage for recovery of Transmission Charges on achieving COD as per Schedule 5 of this Agreement;

"Event of Default" shall mean the events as defined in Article 13 of this Agreement;

"Expiry Date" shall be the date which is thirty five (35) years from the COD of the Project;

"Financial Closure" shall mean the first Business Day on which funds are made available to the TSP pursuant to the Financing Agreements;

"Financially Evaluated Entity" shall mean the company which has been evaluated for the satisfaction of the financial requirement set forth in the RFP;

"Financing Agreements" shall mean the agreements pursuant to which the TSP is to finance the Project including the loan agreements, security documents, notes, indentures, security agreements, letters of credit and other documents, as may be amended, modified, or replaced from time to time, but without in anyway increasing the liabilities of the Nodal Agency;

"Financial Year" shall mean a period of twelve months at midnight Indian Standard Time (IST) between 1st April & 31st March;

"Force Majeure" and **"Force Majeure Event"** shall have the meaning assigned thereto in Article 11;

"GOI" shall mean Government of India;

"Grid Code" / "IEGC" or "State Grid Code" shall mean the Grid Code specified by the Central Commission under clause (h) of sub-section (1) of Section 79 of the Electricity Act and/or the State Grid Code as specified by the concerned State Commission referred under clause (h) of sub-section (1) of Section 86 of the Electricity Act as applicable;

"Independent Engineer" shall mean an agency/ company, appointed by Nodal Agency in accordance with the Guidelines for Encouraging Competition in Development of Transmission Projects.

"Indian Governmental Instrumentality" shall mean Government of India, Government of any State in India or any ministry, department, board, authority, agency, corporation, commission under the direct or indirect control of Government of India or any State Government or both, any political sub-division of any of them including any court or CERC or KERC or tribunal or judicial or quasi-judicial body in India but excluding the CTU, TSP and the PCKL;

"Insurances" shall mean the insurance cover to be obtained and maintained by the TSP in accordance with Article 9 of this Agreement;

"Inter connection Facilities" shall mean the facilities as may be set up for transmission of electricity through the use of the Project, on either one or both side of generating station's / CTU's / STU's / InSTS Licensee's / PCKL substations (as the case may be) which shall include, without limitation, all other transmission lines, gantries, sub-stations and associated equipment not forming part of the Project;

"Invoice" shall mean a Monthly Transmission Charges Invoice or Monthly Bill comprising the Monthly Transmission Charges, as per Schedule 4 hereof, a Supplementary Invoice or any other Invoice or Bill raised by any of the Parties;

"Licensee" shall be the TSP under this Agreement, consequent to having been awarded a Transmission License by the State Commission and shall be referred to as the TSP or the Licensee, as the context may require in this Agreement;

"Law" or "Laws" in relation to this Agreement, shall mean all laws including electricity laws in force in India and any statute, ordinance, rule, regulation, notification, order or code, or any interpretation of any of them by an Indian Governmental Instrumentality having force of law and shall include all rules, regulations, decisions and orders of the State Commission;

"Lead Member of the Bidding Consortium" or "Lead Member" shall mean a company who commits at least 26% equity stake in the Project, meets the technical requirement as specified in the RFP and so designated by other Member(s) in Bidding Consortium;

"Lenders" means the banks, financial institutions, multilateral funding agencies, non-banking financial companies registered with the Reserve Bank of India (RBI), insurance companies registered with the Insurance Regulatory & Development Authority (IRDA), pension funds regulated by the Pension Fund Regulatory & Development Authority (PFRDA),mutual funds registered with Securities & Exchange Board of India (SEBI), etc., including their successors and assigns, who have agreed on or before COD of the Project to provide the TSP with the debt financing described in the capital structure schedule, and any successor banks or financial institutions to whom their interests under the Financing Agreements may be transferred or assigned;

Provided that, such assignment or transfer shall not relieve the TSP of its obligations to the Nodal Agency under this Agreement in any manner and shall also does not lead to an increase in the liability of the Nodal Agency;

"Lenders Representative" shall mean the person notified by the Lender(s) in writing as being the representative of the Lender(s) or the Security Trustee and such person may from time to time be replaced by the Lender(s) pursuant to the Financing Agreements by written notice to the TSP;

"Letter of Credit" or **"LC"** shall mean an unconditional, irrevocable, revolving Letter of Credit opened by the Nodal Agency in favour of the TSP with any scheduled bank;

"Letter of Intent" or **"LOI"** shall have the same meaning as in the RFP;

"Licensee" shall be the TSP under this Agreement, consequent to having been awarded a Transmission License by the State Commission and shall be referred to as the TSP or the Licensee, as the context may require in this Agreement **"Member in a Bidding Consortium / Member"** shall mean each company in the Bidding Consortium;

"Member in a Bidding Consortium / Member" shall mean each company in the Bidding Consortium;

"Month" shall mean a period of thirty (30) days from (and excluding) the date of the event;

"Monthly Transmission Charges" for any Element of the Project, after COD of the Element till COD of the Project, and for the Project after COD of the Project, shall mean the amount of Transmission Charges as specified in Schedule 5 of this Agreement multiplied by no. of days in the relevant month and divided by no. of days in the year;

"National Load Despatch Centre" shall mean the centre established as per sub-section (1) of Section 26 of the Electricity Act 2003;

"State Load Despatch Centre" shall mean the centre established as per sub-section (1) of Section 31 of the Electricity Act 2003;

"**Nodal Agency**" shall mean PCKL, which shall execute and implement the Transmission Service Agreement (TSA);

"Notification" shall mean any notification, issued in the Gazette of India/State Government;

"Operating Period" for any Element of the Project shall mean the period from (and including) the COD of such Element of the Project, up to (and including) the Expiry Date and for the Project, shall mean the period from (and including) the COD of the Project, up to (and including) the Expiry Date;

"Parent Company" shall mean an entity that holds at least twenty six percent (26%) of the paid - up equity capital directly or indirectly in the Bidding Company or in the Member in a Bidding Consortium, as the case may be;

"Payment on Order Instrument" shall mean Letter of Undertaking from Indian Renewable Energy Development Agency Limited (IREDA) or Power Finance Corporation Limited (PFC) or REC Limited (REC) [the three non-banking financial institutions under Ministry of New & Renewable Energy (MNRE)/ Ministry of Power (MoP)], to pay in case situation of default of Transmission Service Provider (TSP) in terms of tender conditions/ Power Purchase Agreement (PPA) arises. Such Letter(s) will have same effect as that of a Bank Guarantee issued by any public sector bank. Such "Payment on Order instrument" would have terms and conditions similar to that of any Bank Guarantee given by any public sector bank and would promise to pay the Nodal Agency on demand within stipulated time. TSPs can seek such Letter(s) by offering due security to the above-mentioned three non-banking financial institutions mentioned above (IREDA, PFC & REC). Nodal Agency shall not accept the instrument of 'Letter of Undertaking' as described above or in any other form, from any other non-banking financial institutions or bank, except IREDA, PFC & REC;

"Preliminary Termination Notice" shall mean a Nodal Agency's Preliminary Termination Notice as defined in Article 13 of this Agreement;

"Project" shall mean "Evacuation Scheme for 2000MW solar park at Ryapte Village, Tumkur District" as detailed in Schedule 1 of this Agreement;

"**Project Assets**" shall mean all physical and other assets relating to and forming part of the Project including:

(a) rights over the Site for substations, ROW for transmission lines;

(b) tangible & intangible assets such as civil works and equipment including foundations, embankments, pavements, electrical systems, communication systems, relief centres, administrative offices, Sub-stations, software, tower and sub-stations designs etc;

(c) project facilities situated on the Site;

(d) all rights of the TSP under the project agreements;

(e) financial assets, such as receivables, security deposits etc;

(f) insurance proceeds; and

(g) Applicable Permits and authorisations relating to or in respect of the Transmission System;"

"Project Execution Plan" shall mean the plan referred to in Article 3.1.3(c) hereof;

"Prudent Utility Practices" shall mean the practices, methods and standards that are generally accepted internationally from time to time by electric transmission utilities for the purpose of ensuring the safe, efficient and economic design, construction, commissioning, operation, repair and maintenance of the Project and which practices, methods and standards shall be adjusted as necessary, to take account of:

(i) operation, repair and maintenance guidelines given by the manufacturers to be incorporated in the Project,

(ii) the requirements of Law, and

(iii) the physical conditions at the Site;

(iv) the safety of operating personnel and human beings;

"Rated Voltage" shall mean voltage at which the Transmission System is designed to operate or such lower voltage at which the line is charged, for the time being, in consultation with the State Transmission Utility;

"Rebate" shall have the meaning as ascribed to in Article 10.3 of this Agreement;

"RFP" shall mean Request for Proposal dated 10.06.2025 along with all schedules, annexures and RFP Project Documents attached thereto, issued by the BPC for tariff based competitive bidding process for selection of Bidder as TSP to execute the Project, including any modifications, amendments or alterations thereto;

"RFP Project Documents" shall mean the following documents to be entered into in respect of the Project, by the Parties to the respective agreements:

a. Transmission Service Agreement,

b. Share Purchase Agreement, and

c. Any other agreement as may be required;

"RLDC" shall mean the relevant Regional Load Dispatch Centre as defined in the Electricity Act, 2003, in the region(s) in which the Project is located;

"RPC" shall mean the relevant Regional Power Committee established by the Government of India for the specific Region(s) in accordance with the Electricity Act, 2003 for facilitating integrated operation of the Power System in that Region;

"Scheduled COD" in relation to an Element(s) shall mean the date(s) as mentioned in Schedule 2 as against such Element(s) and in relation to the Project, shall mean the date as mentioned in Schedule 2 as against such Project, subject to the provisions of Article 4.4 of this Agreement, or such date as may be mutually agreed among the Parties;

"Scheduled Outage" shall mean the final outage plan as approved by the RPC / SLDC as per the provisions of the Grid Code;

"Selected Bid" shall mean the technical Bid and the Final Offer of the Selected Bidder submitted during e-reverse bidding, which shall be downloaded and attached in Schedule 7 on or prior to the Effective Date;

"Share Purchase Agreement" shall mean the agreement amongst REC Power Development and Consultancy Limited, Ryapte Power Transmission Limited and the Successful Bidder for the purchase of one hundred (100%) per cent of the shareholding of the Ryapte Power Transmission Limited for the Acquisition Price, by the Successful Bidder on the terms and conditions as contained therein;

"Site" in relation to a substation, switching station or HVDC terminal or inverter station, shall mean the land and other places upon which such station / terminal is to be established;

"SLDC" shall mean the State Load Despatch Centre established as per sub-section (1) of Section 31 of the Electricity Act 2003;

"State Commission" or "KERC" shall mean the Karnataka Electricity Regulatory Commission referred to in sub-section (1) of section 82 of the Electricity Act, 2003 or its successors and assigns;

"State Government" shall mean the Government of Karnataka;

"STU" or **"State Transmission Utility" of "Karnataka Power Transmission Corporation Limited (KPTCL)"** shall be the Board or the Government company, specified as such by the State Government under sub-section (1) of Section 39 of the Electricity Act 2003;

"Successful Bidder" or **"Selected Bidder"** shall mean the Bidder selected pursuant to the RFP and who has to acquire one hundred percent (100%) equity shares of Ryapte Power Transmission Limited, along with all its related assets and liabilities, which will be responsible as the TSP to establish the Project on build, own, operate and transfer basis as per the terms of the TSA and other RFP Project Documents;

"TSP's Preliminary Notice" shall mean a notice issued by the TSP in pursuant to the provisions of Article 13.3 of this Agreement;

"Target Availability" shall have the meaning as ascribed hereto in Article 8.2 of this Agreement;

"Technically Evaluated Entity" shall mean the company which has been evaluated for the satisfaction of the technical requirement set forth in RFP;

"Termination Notice" shall mean a Nodal Agency's Termination Notice given by the Nodal Agency to the TSP pursuant to the provisions of Articles 3.3.2, 3.3.4, 4.4.2, 5.8, 13.2 and 13.3 of this Agreement for the termination of this Agreement;

"Term of Agreement" for the purposes of this Agreement shall have the meaning ascribed thereto in Article 2.2 of this Agreement;

"Transmission Charges" shall mean the Final Offer of the Selected Bidder during the e-reverse bidding and adopted by the State Commission, payable to the TSP by Nodal Agency as per the provisions of TSA;

"Transmission License" shall mean the license granted by the State Commission in terms of the relevant regulations for grant of such license issued under the Electricity Act;

"Transmission Service" shall mean making the Project available as per the terms and conditions of this Agreement;

"Unscheduled Outage" shall mean an interruption resulting in reduction of the Availability of the Element(s) / Project (as the case may be) that is not a result of a Scheduled Outage or a Force Majeure Event.

"Ultimate Parent Company" shall mean an entity which owns at least twenty six percent (26%) equity in the Bidding Company or Member of a Consortium, (as the case may be) and in the Technically Evaluated Entity and / or Financially Evaluated Entity (as the case may be) and such Bidding Company or Member of a Consortium, (as the case may be) and the Technically Evaluated Entity and / or Financially Evaluated Entity (as the case may be) shall be under the direct control or indirectly under the common control of such entity;

1.2 Interpretation:

Save where the contrary is indicated, any reference in this Agreement to:

"Agreement" shall be construed as including a reference to its Schedules, Appendices and Annexures;

"Rupee", **"Rupees"** and **"Rs."** shall denote lawful currency of India;

"crore" shall mean a reference to ten million (10,000,000) and a **"lakh"** shall mean a reference to one tenth of a million (1,00,000);

"encumbrance" shall be construed as a reference to a mortgage, charge, pledge, lien or other encumbrance securing any obligation of any person or any other type of preferential arrangement (including, without limitation, title transfer and retention arrangements) having a similar effect;

"holding company" of a company or corporation shall be construed as a reference to any company or corporation of which the other company or corporation is a subsidiary;

"indebtedness" shall be construed so as to include any obligation (whether incurred as principal or surety) for the payment or repayment of money, whether present or future, actual or contingent;

"person" shall have the meaning as defined in Section 2(49) of the Act;

"subsidiary" of a company or corporation (the holding company) shall be construed as a reference to any company or corporation:

(i) which is controlled, directly or indirectly, by the holding company, or

(ii) more than half of the issued share capital of which is beneficially owned, directly or indirectly, by the holding company, or

(iii) which is a subsidiary of another subsidiary of the holding company,

for these purposes, a company or corporation shall be treated as being controlled by another if that other company or corporation is able to direct its affairs and/or to control the composition of its board of directors or equivalent body;

"winding-up", **"dissolution"**, **"insolvency"**, or **"reorganization"** in the context of a company or corporation shall have the same meaning as defined in the Companies Act, 1956/ Companies Act, 2013 (as the case may be).

1.2.1 Words importing the singular shall include the plural and vice versa.

1.2.2 This Agreement itself or any other agreement or document shall be construed as a reference to this or to such other agreement or document as it may have been, or may from time to time be, amended, varied, novated, replaced or supplemented.

1.2.3 A Law shall be construed as a reference to such Law including its amendments or re-enactments from time to time.

1.2.4 A time of day shall, save as otherwise provided in any agreement or document be construed as a reference to Indian Standard Time.

1.2.5 Different parts of this Agreement are to be taken as mutually explanatory and supplementary to each other and if there is any inconsistency between or among the parts of this Agreement, they shall be interpreted in a harmonious manner so as to give effect to each part.

1.2.6 The tables of contents and any headings or sub-headings in this Agreement have been inserted for ease of reference only and shall not affect the interpretation of this Agreement.

1.2.7 All interest payable under this Agreement shall accrue from day to day and be calculated on the basis of a year of three hundred and sixty five (365) days.

1.2.8 The words “hereof” or “herein”, if and when used in this Agreement shall mean a reference to this Agreement.

1.2.9 The contents of Schedule 7 shall be referred to for ascertaining accuracy and correctness of the representations made by the Selected Bidder in Article 17.2.1 hereof.

ARTICLE: 2

2 EFFECTIVENESS AND TERM OF AGREEMENT

2.1 Effective Date:

This Agreement shall be effective from later of the dates of the following events:

a. The Selected Bidder, on behalf of the TSP, has provided the Contract Performance Guarantee, as per terms of Article 3.1 of this Agreement; and

b. The Selected Bidder has acquired for the Acquisition Price, one hundred percent (100%) of the equity shareholding of REC Power Development and Consultancy Limited in Ryapte Power Transmission Limited along with all its related assets and liabilities as per the provisions of the Share Purchase Agreement. and

c. The Agreement is executed and delivered by the Parties;

2.2 Term and Termination:

2.2.1 Subject to Article 2.2.3 and Article 2.4, this Agreement shall continue to be effective in relation to the Project until the Expiry Date, when it shall automatically terminate.

2.2.2 Post the Expiry Date of this Agreement, the TSP shall ensure transfer of Project Assets to KPTCL or its successors or an agency as decided by the Government of Karnataka at zero cost and free from any encumbrance and liability. The transfer shall be completed within 90 days of expiry of this Agreement failing which KPTCL or its successors or an agency as decided by the State Government shall be entitled to take over the Project Assets Suo moto.

2.2.3 This Agreement shall terminate before the Expiry Date in accordance with Article 13 or Article 3.3.2 or Article 3.3.4.

2.3 Conditions prior to the expiry of the Transmission License

2.3.1 In order to continue the Project beyond the expiry of the Transmission License, the TSP shall be obligated to make an application to the State Commission at least two (2) years before the date of expiry of the Transmission License, seeking the State Commission's approval for the extension of the term of the Transmission License up to the Expiry Date.

2.3.2 The TSP shall timely comply with all the requirements that may be laid down by the State Commission for extension of the term of the Transmission License beyond the initial term of twenty-five (25) years & upto the Expiry Date and the TSP shall keep the Nodal Agency fully informed about the progress on its application for extension of the term of the Transmission License.

2.4 Survival:

The expiry or termination of this Agreement shall not affect any accrued rights, obligations/ roles and liabilities of the Parties under this Agreement, including the right to receive liquidated damages as per the terms of this Agreement, nor shall it effect the survival of any continuing obligations/ roles for which this Agreement provides, either expressly or by necessary implication, which are to survive after the Expiry Date or termination including those under Articles 3.3.3, 3.3.5, Article 9.3 (Application of Insurance Proceeds), Article 11 (Force Majeure), Article 13 (Events of Default and Termination), Article 14 (Liability & Indemnification), Article 16 (Governing Law & Dispute Resolution), Article 19 (Miscellaneous).

2.5 Applicability of the provisions of this Agreement

2.5.1 For the purpose of Availability, Target Availability and the computation of Availability, Incentive, Penalty, the provisions provided in this Agreement shall apply and any future modifications in the relevant Rules and Regulations shall not be applicable for this Project.

2.5.2 For the purposes of this Agreement for InSTS systems developed under the tariff based competitive bidding framework, the provisions relating to the definitions (Availability and COD), Article 3 (Contract Performance Guarantee and Conditions Subsequent), Article 5 (Construction of the Project), Article 6 (Connection and Commissioning of the Project), Article 8 (Target Availability and calculation of Availability), Article 11 (Force Majeure), Article 12 (Change in Law), Article 13 (Event of Default), Article 14 (Indemnification), Article 15 (Assignment and Charges), Articles16.1,16.2 and 16.4 (Governing Laws and Dispute Resolution) and Article 17 (representation and warranties of the Licensee) of this agreement shall supersede the corresponding provisions of relevant Regulations.

ARTICLE: 3

3 CONDITIONS SUBSEQUENT

3.1 Satisfaction of conditions subsequent by the TSP

3.1.1 Within ten (10) days from the date of issue of Letter of Intent, the Selected Bidder, shall:

a. Provide the Contract Performance Guarantee, and

b. Acquire, for the Acquisition Price, one hundred percent (100%) equity shareholding of Ryapte Power Transmission Limited from REC Power Development and Consultancy Limited, who shall sell to the Selected Bidder, the equity shareholding of Ryapte Power Transmission Limited, along with all its related assets and liabilities.

c. Execute this Agreement;

The TSP shall, within five (5) working days from the date of acquisition of SPV by the Selected Bidder, undertake to apply to the State Commission for the grant of Transmission License and for the adoption of tariff as required under section-63 of the Electricity Act.

The Selected Bidder, on behalf of the TSP, will provide to the Power Company of Karnataka Limited (being the Nodal Agency) the Contract Performance Guarantee for an amount of Rs 49.46 Crore (Rupees Forty-Nine Crore and Forty-Six Lakh Only).

3.1.2 The Contract Performance Guarantee shall be initially valid for a period up to three (3) months after the Scheduled COD of the Project and shall be extended from time to time to be valid for a period up to three (3) months after the COD of the Project. In case the validity of the Contract Performance Guarantee is expiring before the validity specified in this Article, the TSP shall, at least thirty (30) days before the expiry of the Contract Performance Guarantee, replace the Contract Performance Guarantee with another Contract Performance Guarantee or extend the validity of the existing Contract Performance Guarantee until the validity period specified in this Article.

3.1.3 The TSP agrees and undertakes to duly perform and complete the following activities within six (6) months from the Effective Date (except for c) below), unless such completion is affected due to any Force Majeure Event, or if any of the activities is specifically waived in writing by the Nodal Agency:

a. To obtain the Transmission License for the Project from the State Commission;

b. To obtain the order for adoption of Transmission Charges by the State Commission, as required under Section 63 of the Electricity Act 2003;

c. To submit to the Nodal Agency, STU & Independent Engineer, the Project Execution Plan, immediately after award of contract(s) and maximum within one hundred and twenty (120) days from the Effective Date. Also, an approved copy each of Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) would be submitted to Independent Engineer &) Nodal Agency in the same time period. The TSP's Project Execution Plan should be in conformity with the Scheduled COD as specified in Schedule 2 of this Agreement, and shall bring out clearly the organization structure, time plan and methodology for executing the Project, award of major contracts, designing, engineering, procurement, shipping, construction, testing and commissioning to commercial operation;

d. To submit to the Nodal Agency, STU & Independent Engineer a detailed bar (GANTT) chart of the Project outlining each activity (taking longer than one Month), linkages as well as durations;

e. To submit to the Nodal Agency, STU & Independent Engineer detailed specifications of conductor meeting the functional specifications specified in RFP;

f. To achieve Financial Closure;

g. To provide an irrevocable letter to the Lenders duly accepting and acknowledging the rights provided to the Lenders under the provisions of Article 15.3 of this Agreement and all other RFP Project Documents; and

h. To award the Engineering, Procurement and Construction contract ("EPC contract") for the design and construction of the Project and shall have given to such Contractor an irrevocable notice to proceed;

3.2 Recognition of Lenders' Rights by the Nodal Agency

3.2.1 The Nodal Agency hereby accepts and acknowledges the rights provided to the Lenders as per Article 15.3 of this Agreement and all other RFP Project Documents.

3.3 Consequences of non-fulfilment of conditions subsequent

3.3.1 If any of the conditions specified in Article 3.1.3 is not duly fulfilled by the TSP even within three (3) Months after the time specified therein, then on and from the expiry of such period and until the TSP has satisfied all the conditions specified in Article 3.1.3, the TSP shall, on a monthly basis, be liable to furnish to Power Company of Karnataka Limited (being the nodal agency) additional Contract Performance Guarantee of Rupees 4.95 Crores (Rs. Four Crore and Ninety-Five Lakh Only) within two (2) Business Days of expiry of every such Month. Such additional Contract Performance Guarantee shall be provided to Power Company of Karnataka Limited (being the nodal agency) in the manner provided in Article 3.1.1 and shall become part of the Contract Performance Guarantee and all the provisions of this Agreement shall be construed accordingly Power Company of Karnataka Limited (being the nodal agency) shall be entitled to hold and / or invoke the Contract Performance Guarantee, including such additional Contract Performance Guarantee, in accordance with the provisions of this Agreement.

3.3.2 Subject to Article 3.3.4, if:

(i) the fulfilment of any of the conditions specified in Article 3.1.3 is delayed beyond nine (9) Months from the Effective Date and the TSP fails to furnish additional Contract Performance Guarantee to the Nodal Agency in accordance with Article 3.3.1 hereof; or

(ii) the TSP furnishes additional Performance Guarantee to the Nodal Agency in accordance with Article 3.3.1 hereof but fails to fulfil the conditions specified in Article 3.1.3 within a period of twelve (12) months from the Effective Date,

the Nodal Agency shall have the right to terminate this Agreement, by giving a Termination Notice to the TSP, in writing, of at least seven (7) days, with a copy to Government of Karnataka, STU and the Lenders' Representative in order to enable the Lenders to exercise right of substitution in accordance with Article 15.3 of this Agreement.

3.3.3 If the Nodal Agency elects to terminate this Agreement as per the provisions of Article 3.3.2, the TSP shall be liable to pay to the Nodal Agency an amount of Rs 49.46 Crore (Rupees Forty-Nine Crore and Forty-Six Lakh Only) as liquidated damages. The Nodal Agency shall be entitled to recover this amount of damages by invoking the Contract Performance Guarantee to the extent of liquidated damages, which shall be required by the Nodal Agency, and the balance shall be returned to TSP, if any.

It is clarified for removal of doubt that this Article shall survive the termination of this Agreement.

3.3.4 In case of inability of the TSP to fulfil the conditions specified in Article 3.1.3 due to any Force Majeure Event, the time period for fulfilment of the condition subsequent as mentioned in Article 3.1.3, may be extended for a period of such Force Majeure Event. Alternatively, if deemed necessary, this Agreement may be terminated by the Nodal Agency giving a Termination Notice to the TSP, in writing, of at least seven (7) days, with a copy to Government of Karnataka, STU and the Lenders' Representative in order to enable the Lenders to exercise right of substitution in accordance with Article 15.3 of this Agreement and the Contract Performance Guarantee shall be returned as per the provisions of Article 6.5.1.

Provided, that due to the provisions of this Article 3.3.4, any increase in the time period for completion of conditions subsequent mentioned under Article 3.1.3, shall lead to an equal increase in the time period for the Scheduled COD. If the Scheduled COD is extended beyond a period of one hundred eighty (180) days due to the provisions of this Article 3.3.4, the TSP will be allowed to recover the interest cost during construction corresponding to the period exceeding one hundred eighty (180) days by adjustment in the Transmission Charges in accordance with Schedule 9.

3.3.5 Upon termination of this Agreement as per Articles 3.3.2 and 3.3.4, the Nodal Agency may take steps to bid out the Project again.

3.3.6 The Nodal agency, on the failure of the TSP to fulfil its obligations, if it considers that there are sufficient grounds for so doing, apart from invoking the Contract Performance Guarantee under para 3.3.3 may also initiate proceedings for blacklisting the TSP as per provisions of Article 13.2 of TSA.

3.4 Progress Reports

The TSP shall notify the Nodal Agency and STU in writing at least once a Month on the progress made in satisfying the conditions subsequent in Articles 3.1.3.

ARTICLE: 4

4 DEVELOPMENT OF THE PROJECT

4.1 TSP's obligations in development of the Project:

Subject to the terms and conditions of this Agreement, the TSP at its own cost and expense shall observe, comply with, perform, undertake and be responsible:

a. for procuring and maintaining in full force and effect all Consents, Clearances and Permits, required in accordance with Law for development of the Project;

b. for financing, constructing, owning and commissioning each of the Element of the Project for the scope of work set out in Schedule 1 of this Agreement in accordance with:

i. the Electricity Act and the Rules made thereof;

ii. the Grid Code;

iii. the CEA Regulations applicable, and as amended from time to time, for Transmission Lines and sub-stations:

- the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007;
- Central Electricity Authority (Technical Standards for construction of Electrical Plants and Electric Lines) Regulation, 2010;
- Central Electricity Authority (Grid Standard) Regulations, 2010;
- Central Electricity Authority (Safety requirements for construction, operation and maintenance of Electrical Plants and Electrical Lines) Regulation, 2011;
- Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulation, 2010;
- Central Electricity Authority (Technical Standards for Communication System in Power System Operation) Regulations, 2020.

iv. Safety/ security Guidelines laid down by the Central Government and State Government;

v. Prudent Utility Practices, relevant Indian Standards and the Law;

not later than the Scheduled COD as per Schedule 2 of this Agreement;

c. for entering into a Connection Agreement with the concerned parties in accordance with the Grid Code.

d. for owning the Project throughout the term of this Agreement free and clear of any encumbrances except those expressly permitted under Article 15 of this Agreement;

e. to co-ordinate and liaise with concerned agencies and provide on a timely basis relevant information with regard to the specifications of the Project that may be required for interconnecting the Project with the Inter connection Facilities;

f. for providing all assistance to the Arbitrators as they may require for the performance of their duties and responsibilities;

g. to provide to the Nodal Agency and STU, on a monthly basis, progress reports with regard to the Project and its execution (in accordance with prescribed form) to enable the STU to monitor and co-ordinate the development of the Project matching with the Interconnection Facilities;

h. to comply with Ministry of Power order no. 25-11/6/2018 – PG dated 02.07.2020 as well as other Guidelines issued by Govt. of India pertaining to this;

i. to procure the products associated with the Transmission System as per provisions of Public Procurement (Preference to Make in India) orders issued by Ministry of Power vide orders No. A-1/2021-FSC- Part(5) dated 16.11.2021 and No.: P45021/2/2017-PP (BE-II)-Part-4 Vol.II dated 19.07.2024 issued by Ministry of Power for transmission sector, as amended from time to time read with Department for Promotion of Industry and Internal Trade (DPIIT) orders in this regard (Procuring Entity as defined in above orders shall deemed to have included Selected Bidder and/ or TSP).

Also, to comply with Department of Expenditure, Ministry of Finance vide Order (Public Procurement No 1) bearing File No. 6/18/2019-PPD dated 23.07.2020, Office Memorandum (OM) No. F.18/37/2020-PPD dated 08.02.2021, OM No. F.12/1/2021-PPD(Pt.) dated 02.03.2021, OM No. F.7/10/2021-PPD dated 08.06.2021 and Order (Public Procurement No 4) bearing File

No. F.7/10/2021-PPD dated 23.02.2023 as amended from time to time, regarding public procurement from a bidder of a country, which shares land border with India;

j. to submit to Nodal Agency information in the prescribed format [To be devised by Nodal Agency for ensuring compliance to Article 4.1 i) above.

k. to comply with all its obligations undertaken in this Agreement.

4.2 Roles of the Nodal Agency in implementation of the Project:

4.2.1 Subject to the terms and conditions of this Agreement, the Nodal Agency shall be the holder and administrator of this Agreement and shall inter alia:

a. appoint an Independent Engineer within 90 days of the Effective Date

b. provide letters of recommendation to the concerned Indian Governmental Instrumentality, as may be requested by the TSP from time to time, for obtaining the Consents, Clearances and Permits required for the Project;

c. coordinate among TSP and upstream/downstream entities in respect of Interconnection Facilities; and

d. monitor the implementation of the Agreement and take appropriate action for breach thereof including revocation of guarantees, cancellation of Agreement, blacklisting etc

e. provide all assistance to the Arbitrators as required for the performance of their duties and responsibilities; and

f. perform any other responsibility (ies) as specified in this Agreement.

4.3 Time for Commencement and Completion:

a. The TSP shall take all necessary steps to commence work on the Project from the Effective Date of the Agreement and shall achieve Scheduled COD of the Project in accordance with the time schedule specified in Schedule 2 of this Agreement;

b. The COD of each Element of the Project shall occur no later than the Scheduled COD or within such extended time to which the TSP shall be entitled under Article 4.4 hereto.

4.4 Extension of time:

4.4.1 In the event that the TSP is unable to perform its obligations for the reasons solely attributable to the Nodal Agency, the Scheduled COD shall be extended, by a 'day to day' basis, subject to the provisions of Article 13.

4.4.2 In the event that an Element or the Project cannot be commissioned by its Scheduled COD on account of any Force Majeure Event as per Article 11, the Scheduled COD shall be extended, by a 'day to day' basis for a period of such Force Majeure Event. Alternatively, if deemed necessary, the Nodal Agency may terminate the Agreement as per the provisions of Article 13.4 by giving a Termination Notice to the TSP, in writing, of at least seven (7) days, with a copy to Government of Karnataka, STU and the Lenders' Representative in order to enable the Lenders to exercise right of substitution in accordance with Article 15.3 of this Agreement.

4.4.3 If the Parties have not agreed, within thirty (30) days after the affected Party's performance has ceased to be affected by the relevant circumstance, on how long the Scheduled COD should be deferred by, any Party may raise the Dispute to be resolved in accordance with Article 16.

4.5 Metering Arrangements:

4.5.1 The TSP shall comply with all the provisions of the Grid Code and the Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006 as amended from time to time, with regard to the metering arrangements for the Project. The TSP shall fully cooperate with the CTU / STU / RLDC and extend all necessary assistance in taking meter readings.

4.6 Interconnection Facilities:

4.6.1 Subject to the terms and conditions of this Agreement, the TSP shall be responsible for connecting the Project with the Interconnection point(s) specified in Schedule 1 of this Agreement. The Interconnection Facilities shall be developed as per the scope of work and responsibilities assigned in Schedule 1 of this Agreement. The Nodal Agency shall be responsible for coordinating to make available the Interconnection Facilities.

4.6.2 In order to remove any doubts, it is made clear that the obligation of the TSP within the scope of the project is to construct the Project as per Schedule-1 of this Agreement and in particular to connect it to the Interconnection Facilities as specified in this Agreement.

ARTICLE: 5

5 CONSTRUCTION OF THE PROJECT

5.1 TSP's Construction Responsibilities:

5.1.1 The TSP, at its own cost and expense, shall be responsible for designing, constructing, erecting, testing and commissioning each Element of the Project by the Scheduled COD in accordance with the Regulations and other applicable Laws specified in Article 4.1 of this Agreement.

5.1.2 The TSP acknowledges and agrees that it shall not be relieved from any of its obligations under this Agreement or be entitled to any extension of time or any compensation whatsoever by reason of the unsuitability of the Site or Transmission Line route(s).

5.1.3 The TSP shall be responsible for obtaining all Consents, Clearances and Permits related but not limited to road / rail / river / canal / power line / crossings, Power and Telecom Coordination Committee (PTCC), defence, civil aviation, right of way / way-leaves and environmental & forest clearances from relevant authorities required for developing, financing, constructing, maintaining/ renewing all such Consents, Clearances and Permits in order to carry out its obligations under this Agreement in general and shall furnish to the Nodal Agency such copy/ies of each Consents, Clearances and Permits, on demand. Nodal Agency shall provide letters of recommendation to the concerned Indian Governmental Instrumentality, as may be requested by the TSP from time to time for obtaining the Consents, Clearances and Permits required for the Project

5.1.4 The TSP shall be responsible for:

(a) acquisition of land for location specific substations, switching stations or HVDC terminal or inverter stations. Also, the actual location of Greenfield Substation (Switching Station HVDC Terminal or Inverter Station or in the Scope of TSA;

- For a Generation Pooling Substation shall not be beyond 3 Km radius of the location proposed by the BPC in their Survey Report.
- For load Serving Substation within the scope of TSP shall not be beyond 5 Km radius of the location proposed by the BPC in their Survey Report
- For an intermediate Substation shall not be beyond 10 Km radius of the location proposed by the BPC in their Survey Report.

(b) final selection of Site including its geo-technical investigation;

(c) survey and geo-technical investigation of line route in order to determine the final route of the Transmission Lines;

(d) seeking access to the Site and other places where the Project is being executed, at its own risk and costs, including payment of any crop, tree compensation or any other compensation as may be required.

5.1.5 In case the Project involves any resettlement and rehabilitation, the resettlement and rehabilitation package will be implemented by the State Government authorities, for which the costs is to be borne by the TSP and no changes would be allowed in the Transmission Charges on account of any variation in the resettlement and rehabilitation cost. The TSP shall provide assistance on best endeavour basis, in implementation of the resettlement and rehabilitation package, if execution of such package is in the interest of expeditious implementation of the Project and is beneficial to the Project affected persons.

5.2 Appointing Contractors:

5.2.1 The TSP shall conform to the requirements as provided in this Agreement while appointing Contractor(s) for procurement of goods & services.

5.2.2 The appointment of such Contractor(s) shall neither relieve the TSP of any of its obligations under this Agreement nor make the Nodal Agency liable for the performance of such Contractor(s).

5.3 Monthly Progress Reporting:

The TSP shall provide to the STU, Nodal Agency & Independent Engineer, on a monthly basis, progress reports along with likely completion date of each Element with regard to the Project and its execution (in accordance with prescribed form). The Nodal Agency/ STU shall monitor the development of the Project for its timely completion for improving and augmenting the electricity system as a part of its statutory responsibility.

5.4 Quality of Workmanship:

The TSP shall ensure that the Project is designed, built and completed in a good workmanship using sound engineering and construction practices, and using only materials and equipment that are new and manufactured as per the MQP and following approved FQP for erection, testing & commissioning and complying with Indian /International Standards such that, the useful life of the Project will be at least thirty five (35) years from the COD of the Project.

The TSP shall ensure that all major substation equipment / component (e.g. transformers, reactors, Circuit Breakers, Instrument Transformers (IT), Surge Arresters (SA), Protection relays, clamps & connectors etc.), equipment in terminal stations of HVDC installations including Thyristor/ IGBT valves, Converter Transformers, smoothing reactors, Transformer bushings and wall bushings, GIS bus ducts, towers and gantry structures and transmission towers or poles and line materials (conductors, earthwire, OPGW, insulator, accessories for conductors, OPGW & earthwires, hardware fittings for insulators, aviation lights etc), facilities and system shall be designed, constructed and tested (Type test, Routine tests, Factory Acceptance Test (FAT)) in accordance with relevant CEA Regulations and Indian Standards. In case Indian Standards for any particular equipment/ system/ process is not available, IEC/ IEEE or equivalent International Standards and Codes shall be followed.

5.5 Progress Monitoring & Quality Assurance:

5.5.1 The Project Execution Plan submitted by the TSP in accordance with Article 3.1.3 c) shall comprise of detailed schedule of all the equipments / items /materials required for the Project, right from procurement of raw material till the dispatch from works and receipt at the site. Further, it should also include various stages of the construction schedule up to the commissioning of the Project.

5.5.2 Nodal Agency, STU & Independent Engineer shall have access at all reasonable times to the Site and to the Manufacturer's works and to all such places where the Project is being executed.

5.5.3 Independent Engineer shall ensure conformity of the conductor specifications with the functional specifications specified in RFP.

5.5.4 The Independent Engineer shall monitor the following during construction of the Project:

a) Quality of equipments, material, foundation, structures and workmanship etc. as laid down in Article 5.4 and 6.1.4 of the TSA. Specifically, quality of Sub-station equipments, transmission line material and workmanship etc. would be checked in accordance with the Article 5.4.

b) Progress in the activities specified in Condition Subsequent

c) Verification of readiness of the elements including the statutory clearances & completion of civil works, fixing of all components and finalisation of punch points (if any) prior to charging of the elements

d) Progress of construction of substation and Transmission Lines

5.5.5 The progress shall be reviewed by the Independent Engineer against the Project Execution Plan. The Independent Engineer shall prepare its report on monthly basis and submit the same to Nodal Agency highlighting the progress achieved till the end of respective month vis-à-vis milestone activities, areas of concern, if any, which may result in delay in the timely completion of the Project. Based on the progress, Nodal Agency and/ or STU shall issue written instructions to the TSP to take corrective measures, as may be prudent for the timely completion of the Project. In case of any deficiency, the Nodal Agency would be at liberty to take action in accordance with the procedure of this Agreement.

5.5.6 For any delay in commissioning any critical Element(s), as identified in Schedule 1 & Schedule 2 of this Agreement, beyond a period of 45 days shall lead to a sequestration of 10% of the Contract Performance Guarantee.

5.6 Site regulations and Construction Documents

The TSP shall abide by the Safety Rules and Procedures as mentioned in Schedule 3 of this Agreement

The TSP shall retain at the Site and make available for inspection at all reasonable times, copies of the Consents, Clearances and Permits, construction drawings and other documents related to construction.

5.7 Supervision of work:

The TSP shall provide all necessary superintendence for execution of the Project and its supervisory personnel shall be available to provide full-time superintendence for execution of the Project. The TSP shall provide skilled personnel who are experienced in their respective fields.

5.8 Remedial Measures:

The TSP shall take all necessary actions for remedying the shortfall in achievement of timely progress in execution of the Project, if any, as intimated by the Independent Engineer and/ or STU and/ or the Nodal Agency. However, such intimation by the Independent Engineer and/ or STU and/ or Nodal Agency and the subsequent effect of such remedial measures carried out by the TSP shall not relieve the TSP of its obligations in the Agreement. Independent Engineer and/ or STU and/ or the Nodal Agency may carry out random inspections during the Project execution, as and when deemed necessary by it. If the shortfalls as intimated to the TSP are not remedied to the satisfaction of the STU and/ or the Nodal Agency, this Agreement may be terminated by the Nodal Agency by giving a Termination Notice to the TSP, in writing, of at least seven (7) days, with a copy to Government of Karnataka, STU and the Lenders' Representative in order to enable the Lenders to exercise right of substitution in accordance with Article 15.3 of this Agreement.

ARTICLE: 6

6 CONNECTION AND COMMISSIONING OF THE PROJECT

6.1 Connection with the Interconnection Facilities:

6.1.1 The TSP shall give the RLDC(s), CTU, / STU, as the case may be, and any other agencies as required, at least sixty (60) days advance written notice of the date on which it intends to connect an Element of the Project, which date shall not be earlier than its Scheduled COD or Schedule COD extended as per Article 4.4.1 & 4.4.2 of this Agreement, unless mutually agreed to by Parties. Further, any preponing of COD of any element prior to Scheduled COD must be approved by the Nodal Agency,

6.1.2 The RLDC / SLDC (as the case may be) or the CTU / STU (as the case may be), for reasonable cause, including non-availability of Interconnection Facilities as per Article 4.2, can defer the connection for up to fifteen (15) days from the date notified by the TSP pursuant to Article 6.1.1, if it notifies to the TSP in writing, before the date of connection, of the reason for the deferral and when the connection is to be rescheduled. However, no such deferment on one or more occasions would be for more than an aggregate period of thirty (30) days. Further, the Scheduled COD would be extended as required, for all such deferments on “day to day” basis.

6.1.3 Subject to Articles 6.1.1 and 6.1.2, any Element of Project may be connected with the Interconnection Facilities when:

a. it has been completed in accordance with this Agreement and the Connection Agreement;

b. it meets the Grid Code, Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007 as amended from time to time and all other Indian legal requirements, and

c. The TSP has obtained the approval in writing of the Electrical Inspector certifying that the Element is ready from the point of view of safety of supply and can be connected with the Interconnection Facilities.

d. It has satisfactorily met all the testing requirements as per Articles 6.1.4

6.1.4 Site Acceptance Test (SAT)/ pre-commissioning tests of all major substation equipment, component, system, facilities shall be successfully carried out before commissioning. The Type tests, FAT and SAT reports

should be available at the substation / terminal station of HVDC installations for ready reference of operation and maintenance staff and has to be made available to the Independent Engineer appointed for quality monitoring or their authorised representatives, as and when they wish to examine the same.

6.2 Commercial Operation:

6.2.1 An Element of the Project shall be declared to have achieved COD twenty four (24) hours following the connection of the Element with the Interconnection Facilities pursuant to Article 6.1 or seven (7) days after the date on which it is declared by the TSP to be ready for charging but is not able to be charged for reasons not attributable to the TSP subject to Article 6.1.2.

Provided that an Element shall be declared to have achieved COD only after all the Element(s), if any, which are pre-required to have achieved COD as defined in Schedule 2 of this Agreement, have been declared to have achieved their respective COD.

6.2.2 Once any Element of the Project has been declared to have achieved deemed COD as per Article 6.2.1 above, such Element of the Project shall be deemed to have Availability equal to the Target Availability till the actual charging of the Element and to this extent, TSP shall be eligible for the Monthly Transmission Charges applicable for such Element.

6.3 Compensation for Direct Non Natural Force Majeure Event or Indirect Non Natural Force Majeure Event or Natural Force Majeure Event (affecting the Nodal Agency)

6.3.1 If the TSP is otherwise ready to connect the Element(s) of the Project and has given due notice, as per provisions of Article 6.1.1, to the concerned agencies of the date of intention to connect the Element(s) of the Project, where such date is not before the Scheduled COD, but is not able to connect the Element(s) of the Project by the said date specified in the notice, due to Direct Non Natural Force Majeure Event or Indirect Non Natural Force Majeure Event or Natural Force Majeure Event affecting the Nodal Agency, provided such Direct Non Natural Force Majeure Event or Indirect Non Natural Force Majeure Event or Natural Force Majeure Event affecting the Nodal Agency has continued for a period of more than three (3) continuous or non-continuous Months, the TSP shall, until the effects of the Direct Non Natural Force Majeure Event or of Indirect Non Natural Force Majeure Event or Natural Force Majeure Event affecting the Nodal Agency no longer prevent the TSP from connecting the Element(s) of the Project, be deemed to have achieved COD relevant to that date and to this extent, be deemed to have been providing Transmission Service with

effect from the date notified, and shall be treated as follows:

a. In case of delay due to Direct Non Natural Force Majeure Event, TSP is entitled for Transmission Charges calculated on Target Availability for the period of such events in excess of three (3) continuous or non continuous Months in the manner provided in (c) below.

b. In case of delay due to Indirect Non Natural Force Majeure Event or Natural Force Majeure Event affecting the Nodal Agency, TSP is entitled for payment for debt service which is due under the Financing Agreements, subject to a maximum of Transmission Charges calculated on Target Availability, for the period of such events in excess of three (3) continuous or non continuous Months in the manner provided in (c) below.

c. In case of delay due to Direct Non Natural Force Majeure Event or Indirect Non Natural Force Majeure Event or Natural Force Majeure Event affecting the Nodal Agency, the TSP is entitled for payments mentioned in (a) and (b) above, after commencement of Transmission Service, in the form of an increase in Transmission Charges. These amounts shall be paid from the date, being the later of a) the date of cessation of such Indirect Non Natural Force Majeure Event or Natural Force Majeure Event affecting the Nodal Agency and b) the completion of sixty (60) days from the receipt of the Financing Agreements by the Nodal Agency from the TSP.

Provided such increase in Transmission Charges shall be so as to put the TSP in the same economic position as the TSP would have been in case the TSP had been paid amounts mentioned in (a) and (b) above in a situation where the Force Majeure Event had not occurred.

6.4 Liquidated Damages for Delay in achieving COD of Project:

6.4.1 If the TSP fails to achieve COD of any Element of the Project or the Project, by the Element's / Project's Scheduled COD or such Scheduled COD as extended under Articles 4.4.1 and 4.4.3, then the TSP shall pay to the Nodal Agency, a sum equivalent to 3.33% of Monthly Transmission Charges applicable for the Element of the Project [in case where no Elements have been defined, to be on the Project as a whole] / Project, for each day of delay up to sixty (60) days of delay and beyond that time limit, at the rate of five percent (5%) of the Monthly Transmission Charges applicable to such Element / Project, as liquidated damages for such delay and not as penalty, without prejudice to any rights of the Nodal Agency under the Agreement.

6.4.2 The TSP's maximum liability under this Article 6.4 shall be limited to the amount of liquidated damages calculated in accordance with Article 6.4.1 for and up to six (6) months of delay for the Element or the Project.

Provided that, in case of failure of the TSP to achieve COD of the Element of the Project even after the expiry of six (6) months from its Scheduled COD, the provisions of Article 13 shall apply.

6.4.3 The TSP shall make payment to the Nodal Agency of the liquidated damages calculated pursuant to Article 6.4.1 within ten (10) days of the earlier of:

a. the date on which the applicable Element achieves COD; or

b. the date of termination of this Agreement.

The payment of such damages shall not relieve the TSP from its obligations to complete the Project or from any other obligation and liabilities under the Agreement.

6.4.4 If the TSP fails to pay the amount of liquidated damages to the Nodal Agency within the said period of ten (10) days, the Nodal Agency shall be entitled to recover the said amount of the liquidated damages by invoking the Contract Performance Guarantee. If the then existing Contract Performance Guarantee is for an amount which is less than the amount of the liquidated damages payable by the TSP to the Nodal Agency under this Article 6.3 and the TSP fails to make payment of the balance amount of the liquidated damages not covered by the Contract Performance Guarantee, then such balance amount shall be deducted from the Transmission Charges payable to the TSP. The right of the Nodal Agency to encash the Contract Performance Guarantee is without prejudice to the other rights of the Nodal Agency under this Agreement.

6.4.5 For avoidance of doubt, it is clarified that amount payable by TSP under this Article is over and above the penalty payable by TSP under Article 5.5.6 of this Agreement.

6.5 Return of Contract Performance Guarantee

6.5.1 The Contract Performance Guarantee as submitted by TSP in accordance with Article 3.1.1 shall be released by the Nodal Agency within three (3) months from the COD of the Project. In the event of delay in achieving Scheduled COD of any of the Elements by the TSP (otherwise than due to reasons as mentioned in Article 3.1.3 or Article 11) and consequent part invocation of the Contract Performance Guarantee by the Nodal Agency. Nodal Agency shall release the Contract Performance Guarantee, if any remaining unadjusted, after the satisfactory completion by the TSP of all

the requirements regarding achieving the Scheduled COD of the remaining Elements of the Project. It is clarified that the Nodal Agency shall also return / release the Contract Performance Guarantee in the event of (i) applicability of Article 3.3.2 to the extent the Contract Performance Guarantee is valid for an amount in excess of Rs 49.46 Crores (Rupees Forty-Nine Crore and Forty-Six Lakh Only) or (ii) termination of this Agreement by the Nodal Agency as mentioned under Article 3.3.4 of this Agreement.

6.5.2 The release of the Contract Performance Guarantee shall be without prejudice to other rights of the Nodal Agency under this Agreement.

ARTICLE: 7

7 OPERATION AND MAINTENANCE OF THE PROJECT

7.1 Operation and Maintenance of the Project:

The TSP shall be responsible for ensuring that the Project is operated and maintained in accordance with the regulations made by the State Commission and CEA from time to time and provisions of the Act.

ARTICLE: 8

8 AVAILABILITY OF THE PROJECT

8.1 Calculation of Availability of the Project:

Calculation of Availability for the Elements and for the Project, as the case may be, shall be as per schedule 6 of this agreement, as applicable on the Bid Deadline and as appended in Schedule 6 of this Agreement.

8.2 Target Availability:

The Target Availability of each Element and the Project shall be 98%.

Payment of monthly Transmission charges based on actual availability will be calculated as per para 1.2 of Schedule 4 of this Agreement.

If the availability of any Element or the Project is below the Target Availability, for six consecutive months in a Contract Year, the Nodal Agency or STU may issue a show cause notice to the TSP, asking them to show cause as to why the Transmission Service Agreement be not terminated, and if no satisfactory cause is shown it may terminate the Agreement. If the Nodal Agency or STU is of the opinion that the transmission system is of critical importance, it may carry out or cause to carry the operation and maintenance of transmission system at the risk and cost of TSP.

ARTICLE: 9

9 INSURANCES

9.1 Insurance:

9.1.1 The TSP shall effect and maintain or cause to be effected and maintained during the Construction Period and the Operating Period, adequate Insurances against such risks, with such deductibles including but not limited to any third party liability and endorsements and co-beneficiary/insured, as may be necessary under

a. any of the Financing Agreements,

b. the Laws, and

c. in accordance with Prudent Utility Practices.

The Insurances shall be taken effective from a date prior to the date of the Financial Closure till the Expiry Date.

9.2 Evidence of Insurance cover:

9.2.1 The TSP shall furnish to the Nodal Agency copies of certificates and policies of the Insurances, as and when the Nodal Agency may seek from the TSP as per the terms of Article 9.1

9.3 Application of Insurance Proceeds:

9.3.1 Save as expressly provided in this Agreement, the policies of Insurances and the Financing Agreements, the proceeds of any insurance claim made due to loss or damage to the Project or any part of the Project shall be first applied to reinstatement, replacement or renewal of such loss or damage.

9.3.2 If a Natural Force Majeure Event renders the Project no longer economically and technically viable and the insurers under the Insurances make payment on a “total loss” or equivalent basis, the portion of the proceeds of such Insurance available to the TSP (after making admissible payments to the Lenders as per the Financing Agreements) shall be allocated only to the TSP. Nodal Agency and / or STU shall have no claim on such proceeds of the Insurance.

9.3.3 Subject to the requirements of the Lenders under the Financing Agreements, any dispute or difference between the Parties as to whether the Project is no longer economically and technically viable due to a Force Majeure Event or whether that event was adequately covered in accordance with this Agreement by the Insurances shall be determined in accordance with Article 16.

9.4 Effect on liability of the Nodal Agency / STU

9.4.1 The Nodal Agency and STU shall have no financial obligations or liability whatsoever towards the TSP in respect of this Article 9.

ARTICLE: 10

10 BILLING AND PAYMENT OF TRANSMISSION CHARGES

10.1 Subject to provisions of this Article 10, the Monthly Transmission Charges shall be paid to the TSP, in Indian Rupees, on monthly basis as per the provisions of this Agreement, from the date on which an Element(s) has achieved COD until the Expiry Date of this Agreement, unless terminated earlier and in line with the provisions of Schedule 4 of this Agreement.

10.1.1 Delivery of Invoices:

10.1.1.1 TSP's Invoices

a. Commencing with the month following the month in which the COD of an Element (which is first Commissioned) occurs, the TSP shall submit to the Nodal Agency by the fifth day of such and each succeeding month (or, if such day is not a Business Day, the immediately following Business Day) an Invoice in the Agreed Form (the "Monthly Transmission Charge Invoice") signed by the authorised signatory of the TSP setting out the computation of the Monthly Transmission Charges to be paid by the Nodal Agency to the TSP in respect of the immediately preceding month in accordance with this Agreement; and

b. Each Monthly Transmission Charge Invoice shall include detailed calculations of the amounts payable under it, together with such further supporting documentation and information as the Nodal Agency may reasonably require / request, from time to time.

10.1.1.2 Nodal Agency Invoices

a. The Nodal Agency shall (as and when any amount becomes due to be paid by TSP), on the fifth day of the month (or, if such day is not a Business Day, the immediately following Business Day) submit to the TSP an Invoice in the Agreed Form (the "Nodal Agency Invoice") setting out the computation of any amount that may be payable to it by the TSP for the immediately preceding month pursuant to this Agreement.

b. The Nodal Agency's Invoice shall include detailed calculations of the amounts payable under it, together with such further supporting documentation as the TSP may reasonably require/request, from time to time.

10.1.2 Payment of Invoices:

10.1.2.1 Any amount payable under an Invoice shall be paid in immediately available and freely transferable clear funds, for value on or before the Due Date, to such account of the TSP or Nodal Agency as shall have been previously notified to Nodal Agency or the TSP, as the case may be.

10.1.2.2 Where in respect of any month there is both:

a. an amount payable by the Nodal Agency to TSP pursuant to a Monthly Transmission Charge Invoice and

b. an amount payable by the TSP to Nodal Agency pursuant to a Nodal Agency Invoice as per provisions of this Agreement,

the two amounts, to the extent agreed to be set off by the TSP may, be set off against each other and the balance, if any, shall be paid by Nodal Agency to the TSP or by TSP to Nodal Agency, as the case may be.

10.1.2.3 The Nodal Agency shall pay the amount payable under the Monthly Transmission Charge Invoice and the Supplementary Bill on the Due Date to such account of the TSP, as shall have been previously notified by the TSP to the Nodal Agency in accordance with Article 10.1.2.6 below.

10.1.2.4 All payments made by the Nodal Agency shall be appropriated by the TSP in the following order of priority:

i. towards Late Payment Surcharge, payable to the TSP, if any;

ii. towards earlier unpaid Monthly Transmission Charge Invoice, if any;

iii. towards earlier unpaid Supplementary Bill, if any;

iv. towards the then current Monthly Transmission Charge Invoice, if any; and

v. towards the then current Supplementary Bill.

10.1.2.5 All payments required to be made under this Agreement shall only include any deduction or set off for:

i. deductions required by the Law; and

ii. amounts claimed by the Nodal Agency from the TSP, through an Invoice duly acknowledged by the TSP, to be payable by the TSP, and not disputed by the TSP within thirty (30) days of receipt of the said Invoice and such deduction or set-off shall be made to the extent of the amounts not disputed. It is clarified that the Nodal Agency shall be entitled to claim any set off or deduction under this Article, after expiry of the said thirty (30) day period.

Provided further, the maximum amounts that can be deducted or set-off by all the Nodal Agency taken together under this Article in a Contract Year shall not exceed Rs. 16.49 Crores (Rupees Sixteen Crore Forty-nine Lakh Only), except on account of payments under sub Article (i) above.

10.1.2.6 The TSP shall open a bank account at …… [Insert identified place or account] (the "Designated Account") for all payments to be made by the Nodal Agency to the TSP, and notify the Nodal Agency of the details of such account at least ninety (90) days before the Scheduled COD of the first Element to the Nodal Agency. The Nodal Agency shall, on the day of payment, notify the TSP of the payment made to the Designated Account. The Nodal Agency shall also designate a bank account at …… [Insert identified place] for payments to be made by the TSP to Nodal Agency and notify the TSP of the details of such account ninety (90) days before the Scheduled COD of the first Element.

10.2 Calculation of Monthly Transmission Charges:

The Monthly Transmission Charges for each Contract Year including Incentive & Penalty payment shall be calculated in accordance with the provisions of Schedule 4 of this Agreement.

10.3 Rebate & Late Payment Surcharge:

10.3.1 **Rebate:** In case the Nodal Agency pays to the TSP through any mode of payment in respect of a Monthly Transmission Charge Invoice or Supplementary Bill, the following shall apply:

a. For payment of Invoices through any mode of payment, a Rebate of 2% shall be allowed on the Monthly Transmission Charge Invoice or Supplementary Bill for payments made in full within two Business Day of the receipt of the Invoice; or

b. For payment of Invoices subsequently, but within the Due Date, a Rebate of 1% shall be allowed on the payments made in full.

c. Applicable rate of Rebate at (a) and (b) above shall be based on the date on which the payment has been actually credited to the TSP's account. Any delay in transfer of money to the TSP's account, on account of a statutory holiday, public holiday, or any other reasons shall be to the account of the Nodal Agency provided that the Invoice is not submitted on the day immediately preceding a statutory holiday or public holiday.

d. No Rebate shall be payable on the bills raised on account of Change in Law relating to taxes, duties and cess;

Provided that if the Nodal Agency fails to pay a Monthly Transmission Charge Invoice/ Supplementary Bill or part thereof within and including the Due Date, the TSP shall recover such amount as per provisions of Article 10.4.3.1 (f).

10.3.2 Late Payment Surcharge: Any amount due from one Party to the other, pursuant to this Agreement and remaining unpaid for thirty (30) days after the Due Date, shall bear Late Payment Surcharge @ 1.25% per month on the unpaid amount. Such Late Payment Surcharge shall be calculated on simple rate basis and shall accrue from the Due Date until the amount due is actually received by the payee.

10.4 Disputed Bills, Default in payment by the Nodal Agency & Annual Reconciliation:

10.4.1 Disputed Invoices

10.4.1.1 If either Party does not question or dispute an Invoice within thirty (30) days of receiving it, the Invoice shall be considered correct, complete and conclusive between the Parties.

10.4.1.2 If either Party disputes any item or part of an item set out in any Invoice then that Party shall serve a notice (an "Invoice Dispute Notice") on the other Party setting out (i) the item or part of an item which is in dispute, (ii) its estimate of what such item or part of an item should be, (iii) and with all written material in support of its claim.

10.4.1.3 If the invoicing Party agrees to the claim raised in the Invoice Dispute Notice issued pursuant to Article 10.4.1.2, the invoicing Party shall revise such Invoice within seven (7) days of receiving such notice from the disputing Party and if the disputing Party has already made the excess payment, the invoicing Party shall refund to the disputing Party, such excess amount within fifteen (15) days of receiving such notice. In such a case, the excess amount shall be refunded along with interest at the same

rate as the Late Payment Surcharge, which shall be applied from the date on which such excess payment was made to the invoicing Party and up to and including the date on which such payment has been received as refund.

10.4.1.4 If the invoicing Party does not agree to the claim raised in the Invoice Dispute Notice issued pursuant to Article 10.4.1.2, it shall, within fifteen (15) days of receiving the Invoice Dispute Notice, furnish a notice to the disputing Party providing (i) reasons for its disagreement; (ii) its estimate of what the correct amount should be; and (iii) all written material in support of its counter-claim.

10.4.1.5 Upon receipt of notice of disagreement to the Invoice Dispute Notice under Article 10.4.1.4, authorised representative(s) or a director of the board of directors/member of board of each Party shall meet and make best endeavours to amicably resolve such Dispute within fifteen (15) days of receiving such notice of disagreement to the Invoice Dispute Notice.

10.4.1.6 If the Parties do not amicably resolve the dispute within fifteen (15) days of receipt of notice of disagreement to the Invoice Dispute Notice pursuant to Article 10.4.1.4, the matter shall be referred to Appropriate Commission for Dispute resolution in accordance with Article 16.

10.4.1.7 If a Dispute regarding a Monthly Transmission Charge Invoice or a Supplementary Invoice is settled pursuant to Article 10.3.1 or by Dispute resolution mechanism provided in this Agreement in favour of the Party that issues the Invoice Dispute Notice, the other Party shall refund the amount, if any incorrectly charged and collected from the disputing Party or pay as required, within five (5) days of the Dispute either being amicably resolved by the Parties pursuant to Article 10.4.1.5 or settled by Dispute resolution mechanism, along with interest (at the same rate as Late Payment Surcharge) or Late Payment Surcharge from the date on which such payment had been made to the invoicing Party or the date on which such payment was originally due, as may be applicable.

10.4.1.8 For the avoidance of doubt, it is clarified that despite a Dispute regarding an Invoice, the Nodal Agency shall, without prejudice to its right to Dispute, be under an obligation to make payment, of the lower of (a) an amount equal to simple average of last three (3) months Invoices (being the undisputed portion of such three months Invoices) and (b) Monthly Invoice which is being disputed, provided such Monthly Invoice has been raised in accordance with this Agreement.

10.4.2 Payment of Supplementary Bill

10.4.2.1 Either Party may raise a bill on the other Party ("Supplementary Bill") for

payment on account of:

i. adjustments (if any) required by the Regional Energy Account / State Energy Account (as the case may be); or

ii. quarterly or annual reconciliation as per Article 10.4.5; or

iii. Change in Law as provided in Article 12,

and such Bill shall be paid by the other Party.

10.4.3 Payment Security Mechanism:

10.4.3.1 Establishment of Letter of Credit:

(a) Not later than one (1) Month prior to the Scheduled COD of the first Element of the Project, Nodal Agency shall, through a scheduled bank, open a Letter of Credit in favour of the TSP, to be made operative from a date prior to the Due Date of its first Monthly Transmission Charge Invoice under this Agreement and shall be renewed annually.

(b) The draft of the proposed Letter of Credit shall be provided by Nodal Agency to the TSP not later than the Financial Closure of the Project and shall be mutually agreed between the Parties.

(c) The Letter of Credit shall have a term of twelve (12) Months and shall be for an amount:

(i) for the first Contract Year or for each subsequent Contract Year, equal to one point one (1.1) times the estimated average Monthly Transmission Charges based on Target Availability of the Elements or Project with Scheduled COD in such Contract Year, as the case may be;

(ii) Provided that, the TSP shall not make any drawl before the Due Date and shall not make more than one drawal in a month.

Provided further that if at any time, such Letter of Credit amount falls short of the amount specified in Article 10.4.3.1, otherwise than by reason of drawal of such Letter of Credit by the TSP, the Nodal Agency shall restore such shortfall within seven (7) days.

(d) Nodal Agency shall cause the scheduled bank issuing the Letter of Credit to intimate the TSP, in writing regarding establishing of such Letter of Credit.

(e) In case of drawal of the Letter of Credit by the TSP in accordance with the terms of this Article 10.4.3.1, the amount of the Letter of Credit shall be reinstated within seven (7) days from the date of such drawal.

(f) If Nodal Agency fails to pay a Monthly Transmission Charge Invoice / Supplementary Bill or part thereof within and including the Due Date, then, unless an Invoice Dispute Notice is received by the TSP as per the provisions of Article 10.4.1.2, the TSP may draw upon the Letter of Credit, and accordingly the bank shall pay without any reference or instructions from the Nodal Agency, an amount equal to such Monthly Transmission Charge Invoice/Supplementary Bill or part thereof plus Late Payment Surcharge, if applicable, in accordance with Article 10.3.2 above, by presenting to the scheduled bank issuing the Letter of Credit, the following documents:

i. a copy of the Monthly Transmission Charge Invoice/Supplementary Bill which has remained unpaid by Nodal Agency;

ii. a certificate from the TSP to the effect that the Invoice at item (i) above, or specified part thereof, is in accordance with the Agreement and has remained unpaid beyond the Due Date; and

iii. calculations of applicable Late Payment Surcharge, if any.

Provided that failure on the part of the TSP to present the documents for negotiation of the Letter of Credit shall not attract any Late Payment Surcharge on the Nodal Agency.

(g) Nodal Agency shall ensure that the Letter of Credit shall be renewed not later than thirty (30) days prior to its expiry.

(h) All costs relating to opening and maintenance of the Letter of Credit shall be borne by the Nodal Agency. However, the Letter

of Credit negotiation charges shall be borne and paid by the TSP.

(i) If Nodal Agency fails to pay (with respect to a Monthly Bill or Supplementary Bill) an amount exceeding thirty percent (30%) of the most recent undisputed Monthly Bill, for a period of seven (7) days after the Due Date and the TSP is unable to recover the amount outstanding to the TSP through the Letter of Credit,

(i) the TSP shall issue a notice to Nodal Agency within seven (7) days from such period highlighting the nonpayment of such amount by Nodal Agency;

(ii) If Nodal Agency still fails to pay such amount within a period of thirty (30) days after the issue of notice by TSP as mentioned in (i) above, the TSP shall approach the RLDC / SLDC (as the case may be) requesting for the alteration of the schedule of dispatch of the lowest cost power of Nodal Agency from the Central Generating Stations/ State Generating Stations (as the case may be), and the RLDC / SLDC shall continue to reschedule the lowest cost power till all the dues of the TSP are recovered;

- Provided that in this case, the quantum of electricity and the corresponding period in which it would be rescheduled for dispatch shall be corresponding to the amount of default. This electricity will then be dispatched to other utilities by the concerned RLDC/SLDC, as the case may be, during the peak hours, i.e., 7pm to 10 pm. The price of this electricity will be determined as per the UI rate;

- Provided further that the revenue from such diverted power would be used to pay the dues first of the generating company (which would include the capacity charges as well as the energy charges) and the remainder would be available for covering the default amount and the balance (if any), after recovering both the charges, would be paid to the defaulting Nodal Agency.

10.4.4 Payment Intimation

Nodal Agency shall remit all amounts due under an Invoice raised by the TSP to the TSP's account by the Due Date and notify the TSP of such remittance on the same day. Similarly, the TSP shall pay all amounts due under an Invoice raised by Nodal Agency by the Due Date to Nodal Agency’s account and notify Nodal Agency of such payment on the same

day.

10.4.5 Quarterly and Annual Reconciliation

10.4.5.1 Parties acknowledge that all payments made against Monthly Bill(s) and Supplementary Bill(s) shall be subject to quarterly reconciliation at the beginning of the following quarter of each Contract Year and annual reconciliation at the end of each Contract Year to take into account Regional Energy Account/ State Energy Account, adjustments in Transmission Charges payments, Rebates, Late Payment Surcharge, Incentive, Penalty, or any other reasonable circumstance as may be mutually agreed between the Parties.

10.4.5.2 The Parties, therefore, agree that as soon as all such data in respect of any quarter of a Contract Year or a full Contract Year, as the case may be, is available and has been finally verified and adjusted, the TSP and Nodal Agency shall jointly sign such reconciliation statement. Within fifteen (15) days of signing of a reconciliation statement, the TSP or Nodal Agency, as the case may be, shall raise a Supplementary Bill for the payments as may be due as a result of reconciliation for the relevant quarter/ Contract Year and shall make payment of such Supplementary Bill for the adjustments in Transmission Charges payments for the relevant quarter/Contract Year.

10.4.5.3 Interest / Late Payment Surcharge shall be payable in such a case from the date on which such payment had been made to the invoicing Party or the date on which any payment was originally due, as may be applicable. Any dispute with regard to the above reconciliation shall be dealt with in accordance with the provisions of Article 16.

ARTICLE: 11

11 FORCE MAJEURE

11.1 Definitions

11.1.1 The following terms shall have the meanings given hereunder.

11.2 Affected Party

11.2.1 An Affected Party means any Party whose performance has been affected by an event of Force Majeure.

11.2.2 Any event of Force Majeure shall be deemed to be an event of Force Majeure affecting the TSP only if the Force Majeure event affects and results in, late delivery of machinery and equipment for the Project or

construction, completion, commissioning of the Project by Scheduled COD and/or operation thereafter;

11.3 Force Majeure

A 'Force Majeure' means any event or circumstance or combination of events and circumstances including those stated below that wholly or partly prevents or unavoidably delays an Affected Party in the performance of its obligations/ roles under this Agreement, but only if and to the extent that such events or circumstances are not within the reasonable control, directly or indirectly, of the Affected Party and could not have been avoided if the Affected Party had taken reasonable care or complied with Prudent Utility Practices:

(a) **Natural Force Majeure Events:**

i. act of God, including, but not limited to drought, fire and explosion (to the extent originating from a source external to the Site), earthquake, volcanic eruption, landslide, flood, cyclone, typhoon, tornado, or exceptionally adverse weather conditions, which are in excess of the statistical measures for the last hundred (100) years; and

ii. epidemic/ pandemic notified by Indian Governmental Instrumentality.

(b) **Non-Natural Force Majeure Events :**

i. Direct Non–Natural Force Majeure Events

- Nationalization or compulsory acquisition by any Indian Governmental Instrumentality of any material assets or rights of the Affected Party; or

- the unlawful, unreasonable or discriminatory revocation of, or refusal to renew, any Consents, Clearances and Permits required by the Affected Party to perform their obligations/ roles under the RFP Project Documents or any unlawful, unreasonable or discriminatory refusal to grant any other Consents, Clearances and Permits required for the development/ operation of the Project, provided that a Competent Court of Law declares the revocation or refusal to be unlawful, unreasonable and discriminatory and strikes the same down; or

- any other unlawful, unreasonable or discriminatory action on the part of an Indian Governmental Instrumentality which is directed

against the Project, provided that a Competent Court of Law declares the action to be unlawful, unreasonable and discriminatory and strikes the same down.

ii. Indirect Non - Natural Force Majeure Events

- act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, revolution, riot, insurrection, terrorist or military action; or
- radio active contamination or ionising radiation originating from a source in India or resulting from any other Indirect Non Natural Force Majeure Event mentioned above, excluding circumstances where the source or cause of contamination or radiation is brought or has been brought into or near the Site by the Affected Party or those employed or engaged by the Affected Party; or
- industry-wide strikes and labour disturbances, having a nationwide impact in India.

11.4 Force Majeure Exclusions

11.4.1 Force Majeure shall not include (i) any event or circumstance which is within the reasonable control of the Parties and (ii) the following conditions, except to the extent that they are consequences of an event of Force Majeure:

(a) Unavailability, late delivery, or changes in cost of the machinery, equipment, materials, spare parts etc. for the Project;

(b) Delay in the performance of any Contractors or their agents;

(c) Non-performance resulting from normal wear and tear typically experienced in transmission materials and equipment;

(d) Strikes or labour disturbance at the facilities of the Affected Party;

(e) Insufficiency of finances or funds or the Agreement becoming onerous to perform; and

(f) Non-performance caused by, or connected with, the Affected Party's:

i. negligent or intentional acts, errors or omissions;

ii. failure to comply with an Indian Law; or

iii. breach of, or default under this Agreement or any Project

Documents.

(g) Any error or omission in the survey report provided by BPC during the bidding process.

11.5 Notification of Force Majeure Event

11.5.1 The Affected Party shall give notice to the other Party of any event of Force Majeure as soon as reasonably practicable, but not later than seven (7) days after the date on which such Party knew or should reasonably have known of the commencement of the event of Force Majeure. If an event of Force Majeure results in a breakdown of communications rendering it unreasonable to give notice within the applicable time limit specified herein, then the Party claiming Force Majeure shall give such notice as soon as reasonably practicable after reinstatement of communications, but not later than one (1) day after such reinstatement.

Provided that, such notice shall be a pre-condition to the Affected Party's entitlement to claim relief under this Agreement. Such notice shall include full particulars of the event of Force Majeure, its effects on the Party claiming relief and the remedial measures proposed. The Affected Party shall give the other Party regular reports on the progress of those remedial measures and such other information as the other Party may reasonably request about the Force Majeure.

11.5.2 The Affected Party shall give notice to the other Party of (i) the cessation of the relevant event of Force Majeure; and (ii) the cessation of the effects of such event of Force Majeure on the performance of its rights or obligations/ roles under this Agreement, as soon as practicable after becoming aware of each of these cessations.

11.6 Duty to perform and duty to mitigate

To the extent not prevented by a Force Majeure Event, the Affected Party shall continue to perform its obligations/ roles as provided in this Agreement. The Affected Party shall use its reasonable efforts to mitigate the effect of any event of Force Majeure as soon as practicable.

11.7 Available Relief for a Force Majeure Event

Subject to this Article 11,

(a) no Party shall be in breach of its obligations/ roles pursuant to this Agreement to the extent that the performance of its obligations/ roles was prevented, hindered or delayed due to a Force Majeure Event;

(b) each Party shall be entitled to claim relief for a Force Majeure Event affecting its performance in relation to its obligations/ roles under Articles 3.3.4, 4.4.2 and 6.3.1 of this Agreement.

(c) For the avoidance of doubt, it is clarified that the computation of Availability of the Element(s) under outage due to Force Majeure Event, as per Article 11.3 affecting the TSP shall be as per Schedule 6 of this agreement as on Bid Deadline. For the event(s) for which the Element(s) is/are deemed to be available as per Schedule 6 of this agreement, then the Transmission Charges, as applicable to such Element(s), shall be payable as per Schedule 4, for the duration of such event(s).

(d) For so long as the TSP is claiming relief due to any Force Majeure Event under this Agreement, the Nodal Agency may, if it so desires, from time to time on one (1) day notice, inspect the Project and the TSP shall provide the Nodal Agency's personnel with access to the Project to carry out such inspections.

(e) For avoidance of doubt, the TSP acknowledges that for extension of Scheduled COD a period up to one hundred eighty (180) days due to Force Majeure event, no compensation on the grounds such as interest cost, incident expenditure, opportunity cost will be made to the TSP. However, if Scheduled COD is extended beyond a period of one hundred eighty (180) days due to Force Majeure event, the TSP will be allowed to recover the interest cost during construction corresponding to the period exceeding one hundred eighty (180) days by adjustment in the Transmission Charges in accordance with Schedule 9.

ARTICLE: 12

12 CHANGE IN LAW

12.1 Change in Law

12.1.1 Change in Law means the occurrence of any of the following after the Bid Deadline resulting into any additional recurring / non-recurring expenditure by the TSP or any savings of the TSP:

- the enactment, coming into effect, adoption, promulgation, amendment, modification or repeal (without re-enactment or consolidation) in India, of any Law, including rules and regulations framed pursuant to such Law, subject to the provisions under Article 12.1.2;
- a change in the interpretation or application of any Law by any Indian Governmental Instrumentality having the legal power to interpret or apply such Law, or any Competent Court of Law;
- the imposition of a requirement for obtaining any Consents, Clearances and Permits which was not required earlier;
- a change in the terms and conditions prescribed for obtaining any Consents, Clearances and Permits or the inclusion of any new terms or conditions for obtaining such Consents, Clearances and Permits;
- any change in the licensing regulations of the State Commission, under which the Transmission License for the Project was granted if made applicable by such State Commission to the TSP;
- change in wind zone; or
- any change in tax or introduction of any tax made applicable for providing Transmission Service by the TSP as per the terms of this Agreement.

12.1.2 Notwithstanding anything contained in this Agreement, Change in Law shall not cover any change:

a) Taxes on corporate income; and

b) Withholding tax on income or dividends distributed to the shareholders of the TSP.

12.2 Relief for Change in Law

12.2.1 During Construction Period, the impact of increase/decrease in the cost of the Project on the Transmission Charges shall be governed by the formula given in Schedule 9 of this Agreement.

12.2.2 During the Operation Period:

During the operation period, if as a result of Change in Law, the TSP suffers or is benefited from a change in costs or revenue, the aggregate financial effect of which exceeds 0.30% (zero point three percent) of the Annual Transmission Charges in aggregate for a Contract Year, the TSP may notify so to the Nodal Agency and propose amendments to this Agreement so as to place the TSP in the same financial position as it would have enjoyed had there been no such Change in Law resulting in change in costs or revenue as aforesaid.

12.2.3 For any claims made under Articles 12.2.1 and 12.2.2 above, the TSP shall provide to the Nodal Agency documentary proof of such increase / decrease in cost of the Project / revenue for establishing the impact of such Change in Law.

In cases where Change in Law results in decrease of cost and it comes to the notice of Nodal Agency that TSP has not informed Nodal Agency about such decrease in cost, Nodal Agency may initiate appropriate claim.

12.3 Notification of Change in Law:

12.3.1 If the TSP is affected by a Change in Law in accordance with Article 12.1 and wishes to claim relief for such Change in Law under this Article 12, it shall give notice to Nodal Agency of such Change in Law as soon as reasonably practicable after becoming aware of the same.

12.3.2 The TSP shall also be obliged to serve a notice to the Nodal Agency even when it is beneficially affected by a Change in Law.

12.3.3 Any notice served pursuant to Articles 12.3.1 and 12.3.2 shall provide, amongst other things, precise details of the Change in Law and its estimated impact on the TSP.

12.4 Payment on account of Change in Law

12.4.1 The payment for Change in Law shall be through a separate Bill. However, in case of any change in Monthly Transmission Charges by reason of Change in Law, as determined in accordance with this Agreement, the Bills to be raised by the Nodal Agency after such change in Transmission

Charges shall appropriately reflect the changed Monthly Transmission Charges.

ARTICLE: 13

13 EVENTS OF DEFAULT AND TERMINATION

13.1 TSP's Event of Default

The occurrence and continuation of any of the following events shall constitute a TSP Event of Default, unless any such TSP Event of Default occurs as a result of any non-fulfilment of its obligations as prescribed under this Agreement by the Nodal Agency or a Force Majeure Event:

a. After having taken up the construction of the Project, the abandonment by the TSP or the TSP's Contractors of the construction of the Project for a continuous period of two (2) months and such default is not rectified within thirty (30) days from the receipt of notice from the Nodal Agency in this regard;

b. The failure to commission any Element of the Project by the date falling six (6) months after its Scheduled COD unless extended by Nodal Agency as per provisions of this Agreement;

c. If the TSP:

i. assigns, mortgages or charges or purports to assign, mortgage or charge any of its assets or rights related to the Project in contravention of the provisions of this Agreement; or

ii. transfers or novates any of its obligations pursuant to this Agreement, in a manner contrary to the provisions of this Agreement;

Except where such transfer is in pursuance of a Law and

- it does not affect the ability of the transferee to perform, and such transferee has the financial and technical capability to perform, its obligations under this Agreement;
- is to a transferee who assumes such obligations under the Project and this Agreement remains effective with respect to the transferee;

d. If:

i. The TSP becomes voluntarily or involuntarily the subject of any bankruptcy or insolvency or winding up proceedings

and such proceedings remain uncontested for a period of thirty (30) days; or

ii. any winding up or bankruptcy or insolvency order is passed against the TSP; or

iii. the TSP goes into liquidation or dissolution or a receiver or any similar officer is appointed over all or substantially all of its assets or official liquidator is appointed to manage its affairs, pursuant to Law,

Provided that a dissolution or liquidation of the TSP will not be a TSP's Event of Default, where such dissolution or liquidation of the TSP is for the purpose of a merger, consolidation or reorganization with the prior approval of the State Commission as per the provisions of Karnataka Electricity Regulatory Commission (Licensing) Regulations, 2004 or as amended from time to time; or

e. Failure on the part of the TSP to comply with the provisions of Article 19.1 of this Agreement; or

f. the TSP repudiates this Agreement and does not rectify such breach even within a period of thirty (30) days from a notice from the Nodal Agency in this regard; or

g. after Commercial Operation Date of the Project, the TSP fails to achieve monthly Target Availability of 98 %, for a period of six (6) consecutive months or within a non-consecutive period of six (6) months within any continuous aggregate period of eighteen(18) months except where the Availability is affected by Force Majeure Events as per Article 11; or

h. any of the representations and warranties made by the TSP in Article 17 of this Agreement being found to be untrue or inaccurate. Further, in addition to the above, any of the undertakings submitted by the Selected Bidder at the time of submission of the Bid being found to be breached or inaccurate, including but not limited to undertakings from its Parent Company / Affiliates related to the minimum equity obligation; or

i. the TSP fails to complete / fulfil all the activities / conditions within the specified period as per Article 3; or

j. except for the reasons solely attributable to Nodal Agency, the TSP is in material breach of any of its obligations under this Agreement and such material breach is not rectified by the TSP

within thirty (30) days of receipt of notice in this regard from the Nodal Agency; or

k. the TSP fails to take the possession of the land required or HVDC terminal or inverter stations and/ or fails to pay the requisite price to the parties and/ or any State Government authority from whom the land is acquired, within twelve (12) months from the Effective Date.

13.2 Termination Procedure for TSP Event of Default

a. Upon the occurrence and continuance of any TSP's Event of Default under Article 13.1 the Nodal Agency may serve notice on the TSP, with a copy to the Government of Karnataka, STU and the Lenders' Representative, of their intention to terminate this Agreement (a "Nodal Agency's Preliminary Termination Notice"), which shall specify in reasonable detail, the circumstances giving rise to such Nodal Agency's Preliminary Termination Notice.

b. Following the issue of a Nodal Agency's Preliminary Termination Notice, the Consultation Period shall apply and would be for the Parties to discuss as to what steps shall be taken with a view to mitigate the consequences of the relevant Event of Default having regard to all the circumstances.

c. During the Consultation Period, the Parties shall, save as otherwise provided in this Agreement, continue to perform their respective obligations/ roles under this Agreement, and the TSP shall not remove any material, equipment or any part of the Project, without prior consent of the Nodal Agency.

Following the expiry of the Consultation Period, unless the Parties shall have otherwise agreed to the contrary or the circumstances giving rise to Nodal Agency's Preliminary Termination Notice shall have ceased to exist or shall have been remedied, this Agreement may be terminated by the Nodal Agency by giving a Termination Notice to the TSP, in writing, of at least seven (7) days, with a copy to Government of Karnataka, STU and the Lenders' Representative in order to enable the Lenders to exercise right of substitution in accordance with Article 15.3 of this Agreement.

Further, the Nodal Agency may also initiate proceedings to blacklist the TSP & its Affiliates from participation in any RFP issued by BPCs for a period of 5 years.

13.3 Procedure for Nodal Agency's non-fulfilment of Role

a. Upon the Nodal Agency not being able to fulfil its role under Article 4.2, the TSP may serve notice on the Nodal Agency, with a copy to Government of Karnataka, STU and the Lenders' Representative (a "TSP's Preliminary Notice"), which notice shall specify in reasonable detail the circumstances giving rise to such non-fulfilment of role by the Nodal Agency.

b. Following the issue of a TSP's Preliminary Notice, the Consultation Period shall apply.

c. The Consultation Period would be for the Parties to discuss as to what steps shall be taken with a view to mitigate the consequences of the relevant non-fulfilment of role by the Nodal Agency including giving time extension to TSP, having regard to all the circumstances.

d. During the Consultation Period, both Parties shall, save as otherwise provided in this Agreement, continue to perform their respective obligations/ roles under this Agreement.

13.4 Termination due to Force Majeure

13.4.1 In case the Parties could not reach an agreement pursuant to Articles 3.3.4 and 4.4.2 of this Agreement and the Force Majeure Event or its effects continue to be present, the Nodal Agency shall have the right to cause termination of the Agreement. In case of such termination, the Contract Performance Guarantee shall be returned to the TSP as per the provisions of Article 6.5.1.

13.4.2 In case of termination of this Agreement, the TSP shall provide to the Nodal Agency the full names and addresses of its Contractors as well as complete designs, design drawings, manufacturing drawings, material specifications and technical information, as required by the Nodal Agency within thirty (30) days of Termination Notice.

13.5 Termination or amendment due to non-requirement of any Element or Project during construction

13.5.1 In case any Element or Project, which is under construction, is no longer required due to any reason whatsoever, the Nodal Agency may issue a notice to this effect to the TSP.

13.5.2 Nodal agency may also issue notice to the TSP seeking their response to the proposed termination/ amendment (as the case may be) of the Agreement. The Nodal Agency shall issue copy of such notice to Lenders. In the notice, Nodal Agency shall also include an assessment of the

physical progress made by TSP in the Element/ Project (as the case may be) that is no longer required.

13.5.3 The TSP shall neither carry out further investment nor carry out any work on the Element/ Project (as the case may be) that is no longer required after delivery of the notice.

13.5.4 After taking into account the comments of the TSP, the Nodal Agency may terminate the Agreement or amend it if both Parties agree to the amendment.

13.6 Revocation of the Transmission License

13.6.1 The State Commission may, as per the provisions of the Electricity Act, 2003, revoke the Transmission License of the Licensee. Further, in such a case, the Agreement shall be deemed to have been terminated.

13.7 Termination Payment

13.7.1 If Agreement is terminated on account of Force Majeure Events, non-requirement of any Element or Project during Construction, Nodal Agency's non-fulfilment of Role & TSP's Event of Default, the TSP shall be entitled for Termination Payment equivalent to valuation of Project Assets. Upon payment, the Nodal Agency shall take over the Project Assets.

ARTICLE: 14

14 LIABILITY AND INDEMNIFICATION

14.1 Indemnity

14.1.1 The TSP shall indemnify, defend and hold the Nodal Agency harmless against:

(a) any and all third party claims, actions, suits or proceedings against the Nodal Agency for any loss of or damage to property of such third party, or death or injury to such third party, arising out of a breach by the TSP of any of its obligations under this Agreement, except to the extent that any such claim, action, suit or proceeding has arisen due to a negligent act or omission, breach of this Agreement or non-fulfilment of statutory duty on the part of Nodal Agency; and

(b) any and all losses, damages, costs and expenses including legal costs, fines, penalties and interest actually suffered or incurred by the Nodal Agency from third party claims arising by reason of:

i. a breach by the TSP of any of its obligations under this Agreement, (provided that this Article 14 shall not apply to such breaches by the TSP, for which specific remedies have been provided for under this Agreement) except to the extent that any such losses, damages, costs and expenses including legal costs, fines, penalties and interest (together to constitute “Indemnifiable Losses”) has arisen due to a negligent act or omission, breach of this Agreement or non-fulfilment of statutory duty on the part of the Nodal Agency, or

ii. any of the representations and warranties of the TSP under this Agreement being found to be inaccurate or untrue.

14.1.2 The Nodal Agency shall, in accordance with the Regulations framed by KERC in this regard, indemnify, defend and hold the TSP harmless against:

(a) any and all third party claims, actions, suits or proceedings against the TSP, for any loss of or damage to property of such third party, or death or injury to such third party, arising out of any material breach by the Nodal Agency of any of their roles under this Agreement, except to the extent that any such claim, action, suit or proceeding has arisen due to a negligent act or omission, breach of this Agreement or breach of statutory duty on the part of the TSP, its Contractors, servants or agents; and

(b) any and all losses, damages, costs and expenses including legal costs, fines, penalties and interest ('Indemnifiable Losses') actually suffered or incurred by the TSP from third party claims arising by reason of:

i. any material breach by the Nodal Agency of any of its roles under this Agreement (provided that, this Article 14 shall not apply to such breaches by the Nodal Agency, for which specific remedies have been provided for under this Agreement), except to the extent that any such Indemnifiable Losses have arisen due to a negligent act or omission, breach of this Agreement or breach of statutory duty on the part of the TSP, its Contractors, servants or agents or

ii. any of the representations and warranties of the Nodal Agency under this Agreement being found to be inaccurate or untrue.

14.2 Patent Indemnity:

14.2.1

(a) The TSP shall, subject to the Nodal Agency's compliance with Article 14.2.1 (b), indemnify and hold harmless the Nodal Agency and its employees and officers from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Nodal Agency may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Agreement by reason of the setting up of the Project by the TSP.

Such indemnity shall not cover any use of the Project or any part thereof other than for the purpose indicated by or to be reasonably inferred from the Agreement, any infringement resulting from the misuse of the Project or any part thereof, or any products produced in association or combination with any other equipment, plant or materials not supplied by the TSP, pursuant to the Agreement.

(b) If any proceedings are brought or any claim is made against the Nodal Agency arising out of the matters referred to in Article 14.2.1(a), the Nodal Agency shall promptly give the TSP a notice thereof, and the TSP shall at its own expense take necessary steps and attend such proceedings or claim and any negotiations for the settlement of any such proceedings or claim. The TSP shall promptly notify the Nodal Agency of all actions taken in such proceedings or

claims.

(c) If the TSP fails to notify the Nodal Agency within twenty-eight (28) days after receipt of such notice from the Nodal Agency under Article 14.2.1(b) above, that it intends to attend any such proceedings or claim, then the Nodal Agency shall be free to attend the same on their own behalf at the cost of the TSP. Unless the TSP has so failed to notify the Nodal Agency within the twenty eight (28) days period, the Nodal Agency shall make no admission that may be prejudicial to the defence of any such proceedings or claims.

(d) The Nodal Agency shall, at the TSP's request, afford all available assistance to the TSP in attending to such proceedings or claim, and shall be reimbursed by the TSP for all reasonable expenses incurred in so doing.

14.2.2

(a) The Nodal Agency, in accordance with the Regulations framed by KERC in this regard, subject to the TSP's compliance with Article 14.2.2(b) shall indemnify and hold harmless the TSP and its employees, officers from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs and expenses of whatsoever nature, including attorney's fees and expenses, which the TSP may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Agreement by reason of the setting up of the Project by the TSP.

(b) If any proceedings are brought or any claim is made against the TSP arising out of the matters referred to in Article 14.2.2 (a) the TSP shall promptly give the Nodal Agency a notice thereof, and the Nodal Agency shall at its own expense take necessary steps and attend such proceedings or claim and any negotiations for the settlement of any such proceedings or claim. The Nodal Agency shall promptly notify the TSP of all actions taken in such proceedings or claims.

(c) If the Nodal Agency fails to notify the TSP within twenty-eight (28) days after receipt of such notice from the TSP under Article 14.2.2(b) above, that it intends to attend any such proceedings or claim, then the TSP shall be free to attend the same on its own behalf at the cost of the Nodal Agency. Unless the Nodal Agency has so failed to notify the TSP within the twenty (28) days period, the TSP shall make no admission that may be prejudicial to the defence of any such proceedings or claim.

(d) The TSP shall, at the Nodal Agency request, afford all available assistance to the Nodal Agency in attending to such proceedings or claim, and shall be reimbursed by the Nodal Agency for all reasonable expenses incurred in so doing.

14.3 Monetary Limitation of liability

14.3.1 A Party ("Indemnifying Party") shall be liable to indemnify the other Party ("Indemnified Party") under this Article 14 for any indemnity claims made in a Contract Year only up to an amount of Rupees 3.30 Crore Only (Rs. Three Crore and Thirty Lakh Only)**.**

14.4 Procedure for claiming indemnity

14.4.1 Where the Indemnified Party is entitled to indemnification from the Indemnifying Party pursuant to Articles 14.1 or 0 the Indemnified Party shall promptly notify the Indemnifying Party of such claim, proceeding, action or suit referred to in Articles 14.1 or 0 in respect of which it is entitled to be indemnified. Such notice shall be given as soon as reasonably practicable after the Indemnified Party becomes aware of such claim, proceeding, action or suit. The Indemnifying Party shall be liable to settle the indemnification claim within thirty (30) days of receipt of the above notice.

Provided however that, if:

i. the Parties choose to contest, defend or litigate such claim, action, suit or proceedings in accordance with Article 14.4.3 below; and

ii. the claim amount is not required to be paid/deposited to such third party pending the resolution of the Dispute,

the Indemnifying Party shall become liable to pay the claim amount to the Indemnified Party or to the third party, as the case may be, promptly following the resolution of the Dispute, if such Dispute is not settled in favour of the Indemnified Party.

14.4.2 The Indemnified Party may contest, defend and litigate a claim, action, suit or proceeding for which it is entitled to be indemnified under Articles 14.1 or 14.2 and the Indemnifying Party shall reimburse to the Indemnified Party all reasonable costs and expenses incurred by the Indemnified Party. However, such Indemnified Party shall not settle or compromise such claim, action, suit or proceedings without first getting the consent of the Indemnifying Party, which consent shall not be unreasonably withheld or delayed.

14.4.3 An Indemnifying Party may, at its own expense, assume control of the

defence of any proceedings brought against the Indemnified Party if it acknowledges its obligation to indemnify such Indemnified Party, gives such Indemnified Party prompt notice of its intention to assume control of the defence, and employs an independent legal counsel at its own cost that is reasonably satisfactory to the Indemnified Party.

14.5 Limitation on Liability

14.5.1 Except as expressly provided in this Agreement, neither the TSP nor the Nodal Agency nor their respective officers, directors, agents, employees or Affiliates (including, officers, directors, agents or employees of such Affiliates), shall be liable or responsible to the other Party or its Affiliates including its officers, directors, agents, employees, successors, insurers or permitted assigns for incidental, indirect or consequential, punitive or exemplary damages, connected with or resulting from performance or non-performance of this Agreement, or anything done in connection herewith, including claims in the nature of lost revenues, income or profits (other than payments expressly required and properly due under this Agreement), any increased expense of, reduction in or loss of transmission capacity or equipment used therefore, irrespective of whether such claims are based upon breach of warranty, tort (including negligence, whether of the Nodal Agency, the TSP or others), strict liability, contract, breach of statutory duty, operation of law or otherwise.

14.5.2 The Nodal Agency shall have no recourse against any officer, director or shareholder of the TSP or any Affiliate of the TSP or any of its officers, directors or shareholders for such claims excluded under this Article. The TSP shall also have no recourse against any officer, director or shareholder of the Nodal Agency, or any Affiliate of the Nodal Agency or any of its officers, directors or shareholders for such claims excluded under this Article.

14.6 Duty to Mitigate

The party entitled to the benefit of an indemnity under this Article 14 shall take all reasonable measures to mitigate any loss or damage which has occurred. If the Party fails to take such measures, the other Party's liabilities shall be correspondingly reduced.

ARTICLE: 15

15 ASSIGNMENTS AND CHARGES

15.1 Assignments:

15.1.1 This Agreement shall be binding upon, and inure to the benefit of the Parties and their respective successors and permitted assigns. This Agreement shall not be assigned by any Party, except as provided in Article 15.3.

15.2 Permitted Charges:

15.2.1 Neither Party shall create or permit to subsist any encumbrance over all or any of its rights and benefits under this Agreement.

15.2.2 However, the TSP may create any encumbrance over all or part of the receivables, or the Project Assets of the Project in favour of the Lenders or the Lenders' Representative on their behalf, as security for amounts payable under the Financing Agreements and any other amounts agreed by the Parties.

Provided that:

i. the Lenders or the Lenders' Representative on their behalf shall have entered into the Financing Agreements and agreed in writing to the provisions of this Agreement; and

ii. any encumbrance granted by the TSP in accordance with this Article 15.2.2 shall contain provisions pursuant to which the Lenders or the Lender's Representative on their behalf agrees unconditionally with the TSP to release from such encumbrances upon payment by the TSP to the Lenders of all amounts due under the Financing Agreements.

15.2.3 Article 15.2.1 does not apply to:

a. liens arising by operation of law (or by an agreement evidencing the same) in the ordinary course of the TSP developing and operating the Project;

b. pledges of goods, the related documents of title and / or other related documents, arising or created in the ordinary course of the TSP developing and operating the Project; or

c. security arising out of retention of title provisions in relation to goods acquired in the ordinary course of the TSP developing and operating the Project.

15.3 Substitution Rights of the Lenders

15.3.1 The TSP would need to operate and maintain the Project under the provisions of this Agreement and cannot assign the Transmission License or transfer the Project or part thereof to any person by sale, lease, exchange or otherwise, without the prior approval of the Nodal Agency.

15.3.2 However, in the case of default by the TSP in debt repayments or in the case of default by the TSP as per Article 13 of this Agreement during the debt repayments, the Commission may, on an application from the Lenders, assign the Transmission License to the nominee of the Lenders subject to the fulfilment of the qualification requirements and provisions of the Karnataka Electricity Regulatory Commission (Licensing) Regulations, 2004 and as amended from time to time.

ARTICLE: 16

16 GOVERNING LAW AND DISPUTE RESOLUTION

16.1 Governing Law:

This Agreement shall be governed by and construed in accordance with the Laws of India. Any legal proceedings in respect of any matters, claims or disputes under this Agreement shall be under the jurisdiction of appropriate courts in Delhi.

16.2 Amicable Settlement:

16.2.1 Either Party is entitled to raise any claim, dispute or difference of whatever nature arising under, out of or in connection with this Agreement, including its existence or validity or termination or whether during the execution of the Project or after its completion and whether prior to or after the abandonment of the Project or termination or breach of the Agreement by giving a written notice to the other Party, which shall contain:

(i) a description of the Dispute;

(ii) the grounds for such Dispute; and

(iii) all written material in support of its claim.

16.2.2 The other Party shall, within thirty (30) days of issue of notice issued under Article 16.2.1, furnish:

(i) counter-claim and defences, if any, regarding the Dispute; and

(ii) all written material in support of its defences and counter-claim.

16.2.3 Within thirty (30) days of issue of notice by the Party pursuant to Article 16.2.1, if the other Party does not furnish any counter claim or defense under Article 16.2.2, or thirty (30) days from the date of furnishing counter claims or defence by the other Party, both the Parties to the Dispute shall meet to settle such Dispute amicably. If the Parties fail to resolve the Dispute amicably within thirty (30) days from the later of the dates mentioned in this Article 16.2.3, the Dispute shall be referred for dispute resolution in accordance with Article 16.3.

16.3 Dispute Resolution:

All Disputes shall be adjudicated by the State Commission.

16.4 Parties to Perform Obligations:

Notwithstanding the existence of any Dispute and difference referred to the State Commission as provided in Article 16.3 and save as the State Commission may otherwise direct by a final or interim order, the Parties hereto shall continue to perform their respective obligations/ roles (which are not in dispute) under this Agreement.

ARTICLE: 17

17 REPRESENTATION AND WARRANTIES

17.1 Representation and warranties of the Nodal Agency

17.1.1 The Nodal Agency hereby represents and warrants to and agrees with the TSP as follows and acknowledges and confirms that the TSP is relying on such representations and warranties in connection with the transactions described in this Agreement:

a. It has all requisite powers and authority to execute and consummate this Agreement;

b. This Agreement is enforceable against the Nodal Agency in accordance with its terms;

c. The consummation of the transactions contemplated by this Agreement on the part of Nodal Agency will not violate any provision of nor constitute a default under, nor give rise to a power to cancel any charter, mortgage, deed of trust or lien, lease, agreement, license, permit, evidence of indebtedness, restriction, or other contract to which the Nodal Agency is a Party or to which the Nodal Agency is bound, which violation, default or power has not been waived;

17.2 Representation and Warranties of the TSP:

17.2.1 The TSP hereby represents and warrants to and agrees with the Nodal Agency as follows and acknowledges and confirms that the Nodal Agency is relying on such representations and warranties in connection with the transactions described in this Agreement:

a. It has all requisite powers and has been duly authorized to execute and consummate this Agreement;

b. This Agreement is enforceable against it, in accordance with its terms;

c. The consummation of the transactions contemplated by this Agreement on the part of the TSP will not violate any provision of nor constitute a default under, nor give rise to a power to cancel any charter, mortgage, deed of trust or lien, lease, agreement, license, permit, evidence of indebtedness, restriction, or other contract to which the TSP is a Party or to which the TSP is bound which violation, default or power has not been waived;

d. The TSP is not insolvent and no insolvency proceedings have been instituted, nor threatened or pending by or against the TSP;

e. There are no actions, suits, claims, proceedings or investigations pending or, to the best of the TSP's knowledge, threatened in writing against the TSP at law, in equity, or otherwise, and whether civil or criminal in nature, before or by, any court, commission, arbitrator or governmental agency or authority, and there are no outstanding judgments, decrees or orders of any such courts, commission, arbitrator or governmental agencies or authorities, which materially adversely affect its ability to execute the Project or to comply with its obligations under this Agreement.

17.2.2 The TSP makes all the representations and warranties above to be valid as on the Effective Date of this Agreement.

ARTICLE: 18

18 INDEPENDENT ENGINEER

18.1 Appointment of Independent Engineer

The Nodal Agency shall appoint an agency/ company as Independent Engineer as per framework provided in the Guidelines for Encouraging Competition in Development of Transmission Projects for selection of Independent Engineer.

18.2 Roles and functions of Independent Engineer

The role and functions of the Independent Engineer shall include the following:

a. Progress Monitoring as required under this Agreement;

b. Ensuring Quality as required under this Agreement;

c. determining, as required under the Agreement, the costs of any works or services and/or their reasonableness during construction phase;

d. determining, as required under the Agreement, the period or any extension thereof, for performing any duty or obligation during construction phase;

e. determining, as required under the Agreement, the valuation of the Project Assets.

f. Assisting the Parties in resolution of Disputes and

g. Undertaking all other duties and functions in accordance with the Agreement.

18.3 Remuneration of Independent Engineer

The fee and charges of the Independent Engineer shall be paid by the Nodal Agency as per terms & conditions of appointment.

18.4 Termination of appointment

18.4.1 The Nodal Agency may, in its discretion, terminate the appointment of the Independent Engineer at any time, but only after appointment of another Independent Engineer.

18.4.2 If the TSP has reason to believe that the Independent Engineer is not discharging its duties and functions in a fair, efficient and diligent manner, it

may make a written representation to the Nodal Agency and seek termination of the appointment of the Independent Engineer. Upon receipt of such representation, the Nodal Agency shall hold a tripartite meeting with the TSP and Independent Engineer for an amicable resolution, and the decision of Nodal agency is final. In the event that the appointment of the Independent Engineer is terminated hereunder, the Nodal Agency shall appoint forthwith another Independent Engineer.

18.5 Authorised signatories

The Nodal Agency shall require the Independent Engineer to designate and notify to the Nodal Agency up to 2 (two) persons employed in its firm to sign for and on behalf of the Independent Engineer, and any communication or document required to be signed by the Independent Engineer shall be valid and effective only if signed by any of the designated persons; provided that the Independent Engineer may, by notice in writing, substitute any of the designated persons by any of its employees.

ARTICLE: 19

19 MISCELLANEOUS PROVISIONS

19.1 Equity Lock-in Commitment:

19.1.1 The aggregate equity share holding of the Selected Bidder in the issued and paid up equity share capital of Ryapte Power Transmission Limited shall not be less than Fifty one percent (51%) up to a period of one (1) year after COD of the Project.

Provided that, in case the Lead Member or Bidding Company is holding equity through Affiliate/s, Ultimate Parent Company or Parent Company, such restriction as specified above shall apply to such entities.

Provided further, that in case the Selected Bidder is a Bidding Consortium, the Lead Member shall continue to hold equity of at least twenty six percent (26%) upto a period of one (1) year after COD of the Project and any Member of such Bidding Consortium shall be allowed to divest its equity as long as the other remaining Members (which shall always include the Lead Member) hold the minimum equity specified above.

19.1.2 If equity is held by the Affiliates, Parent Company or Ultimate Parent Company of the Selected Bidder, then, subject to the second proviso to Article 19.1.1, such Affiliate, Parent Company or Ultimate Parent Company shall be eligible to transfer its shareholding in Ryapte Power Transmission Limited to another Affiliate or to the Parent Company / Ultimate Parent Company of the Selected Bidder. If any such shareholding entity, qualifying as an Affiliate / Parent Company / Ultimate Parent Company, is likely to cease to meet the criteria to qualify as an Affiliate / Parent Company / Ultimate Parent Company, the shares held by such entity shall be transferred to another Affiliate / Parent Company / Ultimate Parent Company of the Selected Bidder.

19.1.3 Subject to Article 19.1.1, all transfer(s) of shareholding of Ryapte Power Transmission Limited by any of the entities referred to in Article 19.1.1 and 19.1.2 above, shall be after prior written intimation to the Nodal Agency.

19.1.4 For computation of effective Equity holding, the Equity holding of the Selected Bidder or its Ultimate Parent Company in such Affiliate(s) or Parent Company and the equity holding of such Affiliate(s) or Ultimate Parent Company in Ryapte Power Transmission Limited shall be computed in accordance with the example given below:

If the Parent Company or the Ultimate Parent Company of the Selected

Bidder A directly holds thirty percent (30%) of the equity in Ryapte Power Transmission Limited then holding of Selected Bidder A in Ryapte Power Transmission Limited shall be thirty percent (30%);

If Selected Bidder A holds thirty percent (30%) equity of the Affiliate and the Affiliate holds fifty percent (50%) equity in Ryapte Power Transmission Limited, then, for the purposes of ascertaining the minimum equity/equity lock-in requirements specified above, the effective holding of Bidder A in Ryapte Power Transmission Limited shall be fifteen percent (15%), (i.e., 30% x 50%)

19.1.5 The provisions as contained in this Article 19.1 shall override the terms of the consortium agreement submitted as part of the Bid.

19.1.6 The TSP shall be responsible to report to Nodal Agency, within thirty (30) days from the occurrence of any event that would result in any change in its equity holding structure from that which existed as on the date of signing of the Share Purchase Agreement. In such cases, the Nodal Agency would reserve the right to ascertain the equity holding structure and to call for all such required documents / information / clarifications as may be required.

19.2 Commitment of maintaining Qualification Requirement

19.2.1 The Selected Bidder will be required to continue to maintain compliance with the Qualification Requirements, as stipulated in RFP Document, till the COD of the Project. Where the Technically Evaluated Entity and/or the Financially Evaluated Entity is not the Bidding Company or a Member in a Bidding Consortium, as the case may be, the Bidding Company or Member shall continue to be an Affiliate of the Technically Evaluated Entity and/or Financially Evaluated Entity till the COD of the Project.

19.2.2 Failure to comply with the aforesaid provisions shall be dealt in the same manner as TSP's Event of Default as under Article 13 of this Agreement.

19.3 Language:

19.3.1 All agreements, correspondence and communications between the Parties relating to this Agreement and all other documentation to be prepared and supplied under the Agreement shall be written in English, and the Agreement shall be construed and interpreted in accordance with English language.

19.3.2 If any of the agreements, correspondence, communications or documents are prepared in any language other than English, the English translation of such agreements, correspondence, communications or documents

shall prevail in matters of interpretation.

19.4 Affirmation

The TSP and the Nodal Agency, each affirm that:

1. neither it nor its respective directors, employees, or agents has paid or undertaken to pay or shall in the future pay any unlawful commission, bribe, pay-off or kick-back; and
2. it has not in any other manner paid any sums, whether in Indian currency or foreign currency and whether in India or abroad to the other Party to procure this Agreement, and the TSP and the Nodal Agency hereby undertake not to engage in any similar acts during the Term of Agreement.

19.5 Severability

The invalidity or enforceability, for any reason, of any part of this Agreement shall not prejudice or affect the validity or enforceability of the remainder of this Agreement, unless the part held invalid or unenforceable is fundamental to this Agreement.

19.6 Counterparts

This Agreement may be executed in one or more counterparts, each of which shall be deemed an original and all of which collectively shall be deemed one and the same Agreement.

19.7 Breach of Obligations/ Roles

The Parties acknowledge that a breach of any of the obligations/ roles contained herein would result in injuries. The Parties further acknowledge that the amount of the liquidated damages or the method of calculating the liquidated damages specified in this Agreement is a genuine and reasonable pre-estimate of the damages that may be suffered by the non-defaulting Party in each case specified under this Agreement.

19.8 Restriction of Shareholders / Owners Liability

19.8.1 Parties expressly agree and acknowledge that none of the shareholders of the Parties hereto shall be liable to the other Parties for any of the contractual obligations of the concerned Party under this Agreement.

19.8.2 Further, the financial liabilities of the shareholder(s) of each Party to this Agreement shall be restricted to the extent provided in the Indian Companies Act, 1956 / Companies Act, 2013 (as the case may be).

19.9 Taxes and Duties:

19.9.1 The TSP shall bear and promptly pay all statutory taxes, duties, levies and cess, assessed/levied on the TSP, its Contractors or their employees that are required to be paid by the TSP as per the Law in relation to the execution of the Project and for providing Transmission Service as per the terms of this Agreement.

19.9.2 The Nodal Agency shall be indemnified and held harmless by the TSP against any claims that may be made against the Nodal Agency in relation to the matters set out in Article 19.9.1.

19.9.3 The Nodal Agency shall not be liable for any payment of, taxes, duties, levies, cess whatsoever for discharging any obligation of the TSP by the Nodal Agency on behalf of TSP or its personnel, provided the TSP has consented in writing to the Nodal Agency for such work, for which consent shall not be unreasonably withheld.

19.10 No Consequential or Indirect Losses

The liability of the TSP shall be limited to that explicitly provided in this Agreement.

Provided that, notwithstanding anything contained in this Agreement, under no event shall the Nodal Agency or the TSP claim from one another any indirect or consequential losses or damages.

19.11 Discretion:

Except where this Agreement expressly requires a Party to act fairly or reasonably, a Party may exercise any discretion given to it under this Agreement in any way it deems fit.

19.12 Confidentiality

19.12.1 The Parties undertake to hold in confidence this Agreement and RFP Project Documents and not to disclose the terms and conditions of the transaction contemplated hereby to third parties, except:

(a) to their professional advisors;

(b) to their officers, contractors, employees, agents or representatives, financiers, who need to have access to such information for the proper performance of their activities; or

(c) disclosures required under Law,

without the prior written consent of the other Parties.

Provided that, the TSP agrees and acknowledges that the Nodal Agency, may, at any time, disclose the terms and conditions of the Agreement and the RFP Project Documents to any person, to the extent stipulated under the Law and the Competitive Bidding Guidelines.

19.13 Order of priority in application:

Save as provided in Article 2.5, in case of inconsistencies between the terms and conditions stipulated in Transmission License issued by the State Commission to the TSP, agreement(s) executed between the Parties, applicable Law including rules and regulations framed thereunder, the order of priority as between them shall be the order in which they are placed below:

- terms and conditions of Transmission License;
- applicable Law, rules and regulations framed thereunder;
- this Agreement;

19.14 Independent Entity:

19.14.1 The TSP shall be an independent entity performing its obligations pursuant to the Agreement.

19.14.2 Subject to the provisions of the Agreement, the TSP shall be solely responsible for the manner in which its obligations under this Agreement are to be performed. All employees and representatives of the TSP or Contractors engaged by the TSP in connection with the performance of the Agreement shall be under the complete control of the TSP and shall not be deemed to be employees, representatives, Contractors of the Nodal Agency and nothing contained in the Agreement or in any agreement or contract awarded by the TSP shall be construed to create any contractual relationship between any such employees, representatives or Contractors and the Nodal Agency.

19.15 Amendments:

19.15.1 This Agreement may only be amended or supplemented by a written agreement between the Parties.

19.16 Waiver:

19.16.1 No waiver by either Party of any default or breach by the other Party in the performance of any of the provisions of this Agreement shall be effective unless in writing duly executed by an authorised representative of such Party.

19.16.2 Neither the failure by either Party to insist on any occasion upon the performance of the terms, conditions and provisions of this Agreement nor time or other indulgence granted by one Party to the other Parties shall act as a waiver of such breach or acceptance of any variation or the relinquishment of any such right or any other right under this Agreement, which shall remain in full force and effect.

19.17 Relationship of the Parties:

This Agreement shall not be interpreted or construed to create an association, joint venture, or partnership or agency or any such other relationship between the Parties or to impose any partnership obligation or liability upon either Party and neither Party shall have any right, power or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party.

19.18 Entirety:

19.18.1 This Agreement along with its sections, schedules and appendices is intended by the Parties as the final expression of their agreement and is intended also as a complete and exclusive statement of the terms of their agreement.

19.18.2 Except as provided in this Agreement, all prior written or oral understandings, offers or other communications of every kind pertaining to this Agreement or the provision of Transmission Service under this Agreement to the Nodal Agency by the TSP shall stand superseded and abrogated.

19.19 Notices:

19.19.1 All notices or other communications which are required to be given under this Agreement shall be in writing and in the English language

19.19.2 If to the TSP, all notices or communications must be delivered personally or by registered post or facsimile or any other mode duly acknowledged to the addressee below:

Address :

Attention :

Email :

Fax. No. :

Telephone No. :

19.19.3 If to the Nodal Agency, all notices or communications must be delivered personally or by registered post or facsimile or any other mode duly acknowledged to the addresses below:

(i) …… [Insert Name of the Nodal Agency]

Address :
Attention
Email :
Fax. No. :
Telephone No. :

19.19.4 All notices or communications given by facsimile shall be confirmed by sending a copy of the same via post office in an envelope properly addressed to the appropriate Party for delivery by registered mail. All notices shall be deemed validly delivered upon receipt evidenced by an acknowledgement of the recipient, unless the Party delivering the notice can prove in case of delivery through the registered post that the recipient refused to acknowledge the receipt of the notice despite efforts of the postal authorities.

19.19.5 Any Party may by notice of at least fifteen (15) days to the other Party change the address and/or addresses to which such notices and communications to it are to be delivered or mailed.

19.20 Fraudulent and Corrupt Practices

19.20.1 The TSP and its respective officers, employees, agents and advisers shall observe the highest standard of ethics during the subsistence of this Agreement. Notwithstanding anything to the contrary contained in the Agreement, the Nodal Agency may terminate the Agreement without being liable in any manner whatsoever to the TSP, if it determines that the TSP has, directly or indirectly or through an agent, engaged in corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice in the Bid process. In such an event, the Nodal Agency shall forfeit the Contract Performance Guarantee of the TSP, without prejudice to any other right or remedy that may be available to the Nodal Agency hereunder or subsistence otherwise.

19.20.2 Without prejudice to the rights of the Nodal Agency under Clause 19.20.1 hereinabove and the rights and remedies which the Nodal Agency may have under this Agreement, if a TSP is found by the Nodal Agency to have directly or indirectly or through an agent, engaged or indulged in any corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice during the Bid process, or after the issue of Letter of Intent (hereinafter referred to as LoI), the Nodal Agency may

terminate the Agreement without being liable in any manner whatsoever to the TSP. Further, the TSP & its Affiliates shall not be eligible to participate in any tender or RFP issued by any BPC for an indefinite period from the date such TSP is found by the Nodal Agency to have directly or indirectly or through an agent, engaged or indulged in any corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practices, as the case may be.

19.20.3 For the purposes of this Clause 19.20, the following terms shall have the meaning hereinafter respectively assigned to them:

(a) **"corrupt practice"** means (i) the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the actions of any person connected with the Bid process (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the BPC who is or has been associated or dealt in any manner, directly or indirectly with the Bid process or the LoI or has dealt with matters concerning the RFP Project Documents or arising there from, before or after the execution thereof, at any time prior to the expiry of one year from the date such official resigns or retires from or otherwise ceases to be in the service of the BPC, shall be deemed to constitute influencing the actions of a person connected with the Bid Process); or (ii) engaging in any manner whatsoever, whether during the Bid Process or after the issue of the LoI or after the execution of the RFP Project Documents, as the case may be, any person in respect of any matter relating to the Project or the LoI or the RFP Project Documents, who at any time has been or is a legal, financial or technical adviser of the BPC in relation to any matter concerning the Project;

(b) "**fraudulent practice**" means a misrepresentation or omission of facts or suppression of facts or disclosure of incomplete facts, in order to influence the Bid process;

(c) "**coercive practice**" means impairing or harming, or threatening to impair or harm, directly or indirectly, any person or property to influence any person's participation or action in the Bid process;

(d) "**undesirable practice**" means (i) establishing contact with any person connected with or employed or engaged by the BPC with the objective of canvassing, lobbying or in any manner influencing or attempting to influence the Bid process; or (ii) having a Conflict of Interest; and

(e) "**restrictive practice**" means forming a cartel or arriving at any understanding or arrangement among Bidders with the objective of restricting or manipulating a full and fair competition in the Bid process;

19.21 Compliance with Law:

Despite anything contained in this Agreement but without prejudice to Article 12, if any provision of this Agreement shall be in deviation or inconsistent with or repugnant to the provisions contained in the Electricity Act, 2003, or any rules and regulations made there under, such provision shall be deemed to be amended to the extent required to bring it into compliance with the aforesaid relevant provisions as amended from time to time.

IN WITNESS WHEREOF, THE PARTIES HAVE CAUSED THIS AGREEMENT TO BE EXECUTED BY THEIR DULY AUTHORISED REPRESENTATIVES AS OF THE DATE AND PLACE SET FORTH ABOVE.

1. For and on behalf of TSP

……..

[Signature, Name, Designation and Address]

2. For and on behalf of .....[Insert name of the Nodal Agency]

……..

[Signature, Name, Designation and Address]

WITNESSES:

1. For and on behalf of

: BPC

……
[Signature]

.....
[Insert, Name, Designation and Address of the Witness]

2. For and on behalf of

: Nodal Agency

……
[Signature]

.....
[Insert Name, Designation and Address of the Witness]

SCHEDULES

Schedule: 1

Project Description and Scope of Project

Scope of the Project:

Sl. No.	Scope of the Transmission Scheme	Scheduled COD in months from Effective Date
1.	Establishment of 5x500 MVA, 400/220 kV S/s at Ryapte in Tumkur District along with 2x125MVAr 400 kV Bus Reactors • 400/220 kV ICTs: 5 Nos. (5x500 MVA) • 400 kV ICT Bays: 5 Nos. • 400 kV Line bays (along with space provision for switchable line reactors) : 2 Nos. • 125 MVAr, 420 kV Bus reactor – 2 Nos. • 400 kV Bus reactor bay: 2 Nos • 220 kV ICT Bays: 5 Nos • 220 KV line Bay - 8 No. • 220 kV TBC bay – 2 No. • 220 kV BC bay – 2 No • 220 kV Sectionalization bay: 1 set • 400 kv Bus PT bay- 2 Nos • 220 kv Bus PT bay- 4 Nos **Space For Future Provision:** • 400/220 KV ICTs - 5 Nos. • 400 KV ICT bay – 5 Nos. • 400 kV Bus Reactor: 3 Nos • 400 kV Bus Reactor bays : 3 Nos • 220 kV ICT Bays: 5 Nos • 220 Kv line bays – 8 Nos • 400 kV Line bays (along with space provision for switchable line reactors) : 4 Nos.	24 Months
2.	400kV DC line (Quad moose conductor) from Prop. 400/220 kV Ryapte Sub-station to Prop. 400/220 kV Doddathaggalli S/s.	
3.	Establishing 3X500 MVA, 400/220kV GIS sub-station at Doddathaggalli (Near	

Sl. No.	Scope of the Transmission Scheme	Scheduled COD in months from Effective Date
	Hosakote) along with 2x125 MVAr, 400 kV Bus Reactors. • 400/220 kV ICTs: 3 no. • 400 kV ICT Bays: 3 Nos • 400 kV Line bays : 4 Nos • 125 MVAr, 420 kV Bus reactor – 2 No • 400 kV Bus reactor bay: 2 Nos • 220 kV ICT Bays: 3 Nos • 220 kV Line bays: 8 Nos. • 220 kV BC bay – 1 No • 400 kv Bus PT bay- 2 Nos • 220 kv Bus PT bay- 2 Nos **Future Provision:** • 400 kV line bays – 4 Nos. • 400/220 kV ICTs - 2 Nos. • 400 kV ICT bays - 2 Nos • 400 kV Bus Reactor: 2 Nos. • 400 kV Bus Reactor bays: 2 Nos. • 220 kV ICT Bays: 2 Nos • 220 kV Line bays: 4 Nos	
4.	400kV DC line (Quad moose conductor) from Kolar S/s to Prop. 400/220 kV Doddathaggalli Sub-station with 2 no. of Outdoor GIS TB at Ex. Kolar S/s of PGCIL by extending existing AIS bus bar along with AIS isolator -	
5.	220 kV DC line with Twin Zebra conductor from proposed 400/220 kV Doddathagalli sub-station to existing 220/66kV Malur sub-station with 2 No.s of TB at Malur S/s.	
6.	220kV DC line with Twin Zebra conductor/UG cable (2000/2500 sqmm) from proposed 400/220 kV Doddathagalli sub-station to 220kV Ekarajapura sub-station with 2 No.s of outdoor GIS TB at Ekarajapura S/s by extending existing AIS bus bar along with AIS isolator.	

Sl. No.	Scope of the Transmission Scheme	Scheduled COD in months from Effective Date
7.	220kV DC line with Twin Zebra conductor/UG cable(2000/2500 sqmm) from proposed 400/220 kV Doddathagalli sub-station to proposed 220kV Hosakote New sub-station.	
8.	220kV DC line with Twin Zebra conductor/ UG Cable (2000/2500 sqmm) from proposed 400/220kV Doddathagalli to Sarjapura AIS S/s ' with 2 No.s of outdoor GIS TB at Sarjapura S/s by extending existing AIS bus bar along with AIS isolator.	

Note:

1. ***KPTCL to provide land for the construction of 400/220 kV sub-station at Doddathagalli and Ryapte and shall be handed over to TSP as is where basis. TSP shall coordinate with KPTCL for acquisition of land.***

Project Description

As per the Report on "Resource Adequacy Assessment of Karnataka from 2024-25 to 2034-35" about 25GW Solar and 13GW Wind generation capacity along with 6GW BESS needs to be added for which additional long term PPAs are to be signed by ESCOMs. M/s Karnataka Renewable Energy Development Ltd (KREDL), the State Nodal Agency for the Government of Karnataka which identifies, promotes and develops Renewable Energy projects in the state has planned to establish 2GW Solar Park at Ryapte in Pavagada Taluk, Tumakuru District.

The above Transmission Evacuation Scheme is planned for reliable evacuation of power from the proposed 2000MW Ryapte Solar Park.

SPECIFIC TECHNICAL REQUIREMENTS FOR TRANSMISSION LINE

1. The design, routing and construction of transmission lines shall be in accordance with Chapter V, Part-A of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022, as amended from time to time. Other CEA Regulations and MoP guidelines, as applicable, shall also be followed.

2. Selection of tower type shall be made as per CEA Regulations, however in case lattice type towers are used, the following shall also be applicable:

2.1. Steel section of grade E 250 and/or grade E 350 as per IS 2062, only are permitted for use in towers, extensions, gantry structures and stub setting templates. For towers in snowbound areas, steel sections shall conform to Grade-C of IS-2062. The minimum size of sections shall be 50 x 50 x 5 for cross arm lower and upper member and 45 x 45 x5 for all other stress carrying members. Use of unequal sections is not permitted. The minimum thickness of angle sections used in the design of towers shall be kept not less than:

6mm: For Main corner leg members including the ground wire peak (including inner & outer members and cross arm).

5mm: For all other members.

2.2. Towers shall be designed as per IS-802:2015, however the drag coefficient of the tower shall be as follows:

Solidity Ratio	Drag Coefficient
Up to 0.05	3.6
0.1	3.4
0.2	2.9
0.3	2.5
0.4	2.2
0.5 and above	2.0

As per Clause 12.1.2.1 b) 2) of IS 802:2015, Under security condition for tension and dead end towers, the transverse loads due to line deviation shall be the component of 100 percent mechanical tension of conductor and ground wire/ OPGW corresponding to 100% of design wind pressure at everyday temperature or 36% design wind pressure at minimum temperature after accounting for drag coefficient and gust response factor. The above loading shall also be considered for design of suspension tower.

Transmission Service Provider (TSP) shall adopt any additional loading/ design criteria for ensuring reliability of the line, if so desired and/ or deemed necessary in accordance with CEA “Technical Standard for Construction of Electrical Plants and Electric Lines” Regulation 2022, as amended from time to time.

3. Type testing of newly designed fully galvanized towers shall be carried out in CPRI/any other NABL accredited tower testing station in India. The Towers shall be erected in vertical position in the test bed and testing shall be carried out in accordance with IS 802 (part-III) with +6M body extensions. All standard tests, including quality control tests in accordance with relevant IS shall be carried out.

4. For power line crossing of 400 kV or above voltage level, large angle & dead end towers (i.e. D/DD/QD) shall be used on either side of power line crossing (i.e. D/DD/QD- D/DD/QD arrangement).

   For overhead crossing of existing power line of 110/132kV and 220kV voltage level, only (D/DD/QD) angle towers shall be used on either side of power line crossing.

   For power line crossing of 66kV and below voltage level, suspension/tension towers shall be provided on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

   For crossing of Railways, National highways and state highways, the rules/regulations of appropriate authorities shall be followed.

5. The conductor configuration shall be as follows:

   For transmission lines with ACSR/AAAC/AL59/HPC conductor:

Transmission line	**ACSR Conductor specified**	**Equivalent AAAC conductor based on 53% conductivity of Al Alloy**	**Equivalent minimum size of AL59 conductor based on 59% conductivity of AL Alloy***	**Sub-conductor Spacing**
400kV D/C (Quad Moose) transmission lines	**Moose: Stranding** 54/3.53 mm-Al + 7/3.53 mm-Steel, 31.77 mm diameter 528.5 mm2, Aluminium area, Maximum DC Resistance at 20°C (Ω/km): 0.05552 Minimum UTS: 161.20 kN	**Stranding details:** 61/3.55 mm 31.95 mm diameter; 604 mm2 Aluminium alloy area Maximum DC Resistance at 20°C (Ω/km): 0.05506 Minimum UTS: 159.80 kN	**Stranding details:** 61/3.31 mm 29.79 mm diameter; 525 mm2 Aluminium alloy area Maximum DC Resistance at 20°C (Ω/km): 0.0566 Minimum UTS: 124.70 kN	457 mm
220 kV D/C (Zebra) transmission lines	Zebra: Stranding 54/3.18 mm-Al + 7/3.18 mm-Steel, 428 Sq mm, Aluminium area, 28.62 mm diameter	**Stranding Details:** 61/3.19 mm 28.71 mm diameter; 487.5 sq.mm Aluminum alloy area	**Stranding Details:** 61/3.08 mm 27.7 mm diameter; 454 sq.mm	NA

			Aluminium alloy area	
132 kV D/C (Panther) transmission lines	Panther: Stranding 30/3.0 mm-Al + 7/3.0 mm-Steel, 261.5 Sq mm, Aluminium area, 21.05 mm diameter	**Stranding Details:**37/3.15 mm 22.05mm Diameter; 288.3 Sq.mm Aluminum alloy area	**Stranding Details:** 37/3.08 mm 21.56mm Diameter; 275.66 Sq.mm Aluminum alloy area	NA

Note:
*i. *To select any size above the minimum, the sizes mentioned in the Indian standard IS-398(part-6) shall be followed.*
ii. The transmission lines shall have to be designed for a maximum operating conductor temperature of 85 deg C for ACSR, 95deg C for AAAC & Al-59.

6. The High Performance Conductors (HPC) shall be as per the standard technical specification issued by CEA.

7. The required phase to phase spacing and horizontal spacing for 400kV, 220kV, and 132kV line shall be governed by the tower design as well as minimum live metal clearances for each voltage level respectively under different insulator swing angles. All electrical clearances including minimum live metal clearance, ground clearance and minimum mid span separation between earth wire and conductor shall be as per Central Electricity Authority (Measures Relating to Safety & Electric Supply) Regulations as amended from time to time and IS: 5613.

For 400kV transmission lines:

The minimum live metal clearances for 400 kV D/C transmission lines shall be considered as follows:

i Under stationary conditions : From tower body: 3.05m
ii Under swing conditions:

Wind pressure Condition	Minimum electrical clearance
a) Swing angle (22º)	3.05 mtrs
b) Swing angle (44º)	1.86 mtrs

However, the phase to phase spacing for 400kV D/C Line shall not be less than 8m.

For 220kV Transmission Lines:

The minimum live metal clearances for 220kV D/C transmission lines shall be considered as follows:

i. Under stationary conditions : From tower body: 2.13m
ii. Under swing conditions:

Wind pressure Condition	Minimum electrical clearance
a) Swing angle (15º)	1.98 mtrs
b) Swing angle (30º)	1.83 mtrs
c) Swing angle (45º)	1.675 mtrs

However, the phase to phase spacing for 220kV D/C Line shall not be less than 5m.

For 132kV Transmission Lines:

The minimum live metal clearances for 132kV D/C transmission lines shall be considered as follows:

i. Under stationary conditions: From tower body: 1.53 m
ii. Under swing conditions:

Wind pressure Condition	Minimum electrical clearance
a) Swing angle (15º)	1.53 mtrs
b) Swing angle (30º)	1.37mtrs
c) Swing angle (45º)	1.22 mtrs
d) Swing angle (60º)	1.07 mtrs

However, the phase to phase spacing for 132 kV D/C Line shall not be less than 4m.

8. The minimum ground clearance for 400kV D/C transmission lines shall be 8.84m, for 220 kV D/C line shall be 7.015 m and for 132 kV D/C line shall be 6.10 m so that maximum electric field does not exceed 10kV/m within the ROW and does not exceed 5kV/m at the edge of the ROW as per international guidelines.

   An allowance of 4% of max sag shall be provided to account for errors in stringing.

   Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26° C lower than the stringing temperature.

9. The minimum mid span separation between earth wire and conductor shall be 9.0 m for 400 kV D/C transmission lines, 8.5 m for 220 kV D/C transmission lines & 6.1 m for 132 kV D/C transmission lines. Shielding angle shall not exceed 20 deg for 400 kV D/C & 30 deg for 220 kV D/C lines and 132 kV D/C lines.

10. Transposition is to be done for all transmission lines whose length is greater than 100km. Transposition should be carried out at 1/3 and 2/3 of line length tower positions.

11. The switching impulse withstand voltage (wet) for 400kV line shall be 1050kVp. Lightning impulse withstand voltage (dry) for 400kV line shall be 1550kVp, for 220 kV line shall be 1050kVp & for 132kV line shall be 650kVp.

12. The Fault current for design of line shall be 63 kA for 1 sec for 400 kV, 50 kA for 1 sec for 220 kV and 40 kA for 1 sec for 132 kV.

13. Porcelain / Glass / Polymer insulators shall be used in the line as per requirement and site conditions. However, porcelain /glass disc insulators string shall be required to be used for Pilot string irrespective of type of insulators used for suspension/tension location.

14. Each tower shall be earthed such that tower footing resistance does not exceed 10 ohms. Pipe type or Counterpoise type earthing shall be provided in accordance with relevant IS. Additional earthing shall be provided on every 7 to 8 kms distance at tension tower for direct earthing of both shield wires. If site condition demands, multiple earthing or use of earthing enhancement compound shall be used. The line surge arrester, if required, may be used in lightning prone areas.

15. Pile type foundation shall be used for towers located in river or creek bed or on bank of river having scourable strata or in areas where river flow or change in river course is anticipated, based on detailed soil investigation and previous years' maximum flood discharge of the river, maximum velocity of water, highest flood level, scour depth & anticipated change in course of river based on river morphology data of at least past 20 years to ensure availability and reliability of the transmission line.

16. Transmission line route shall be finalized, in consultation with appropriate authorities so as to avoid the habitant zones of endangered species and other protected species. Bird diverters, wherever required or mandated, shall be provided on the line. In order to optimize the route use of GATISHAKTI platform shall also be made.

17. Wherever, transmission lines are passing through cyclone prone areas (i.e. areas up to 60 km from coast)/ creek regions/ aggressive soil areas following shall also be applicable:

    1. The fabricated tower parts and stubs shall have a minimum overall zinc coating of 900 g/m2 of surface area except for plates and sections below 5mm which shall have a minimum overall zinc coating of 610g/m2 of surface area. The average zinc coating for all sections and plates 5mm and above shall be maintained as 127 microns and that for plates and sections below 5mm shall be maintained as 87 microns.

    2. Ready mix concrete of M30 Grade shall be used to avoid use of locally available saline water. However, design mix concrete of M30 Grade conforming to IS 456 with potable water can be used at locations where

transportation of ready-mix concrete is not feasible. Minimum cement content in any case shall not be less than 330 kg/m3.

3. The surface of the reinforced steel shall be treated with epoxy-based coating to enhance corrosion performance of foundation. Use of epoxy coated reinforcement in foundation shall be as per IS 13620. In addition, two (2) coats of bituminous painting of minimum 1.6 kg/m2 per coat shall be applied on all exposed faces of foundation (i.e. pedestal and base slab).

4. Double coat 20 mm thick cement plaster shall be provided on all exposed concrete surface as well up to 300 mm below ground level to give protection to concrete surface from environmental and saline effect.

5. Before coping of chimney top portion, three coats of anti-corrosive paint of minimum 30-35 microns dry film thickness each shall be applied on the stub in the 50 mm coping portion as well as up to 350 mm above CL portion.

18. In case of 400kV voltage class lines, at least one out of two earth wires shall be OPGW and second earth wire, if not OPGW, shall be either of galvanized standard steel (GSS) or AACSR or any other suitable conductor type depending upon span length and other technical consideration.

19. The raised chimney foundation is to be provided in areas prone to flooding/water stagnation like paddy field /agricultural field & undulated areas to avoid direct contact of water with steel part of tower. The top of the chimney of foundation should be at least above HFL (High Flood Level) or the historical water stagnation/ logging level (based on locally available data) or above High Tide Level or 500 mm above Natural Ground level (whichever is higher).

20. Transmission line shall be designed considering wind zones as specified in wind map given in National Building Code 2016, Vol.1 and IS:802-2015. The developer shall also make his own assessment of local wind conditions and frequent occurrences of high intensity winds (HIW) due to thunderstorms, dust-storms, downburst etc. along the line route and wherever required, higher wind zone than that given in wind map shall be considered for tower design for ensuring reliability of line. Further, for transmission line sections passing within a distance of 50 km from the boundary of two wind zones, higher of the two wind zones shall be considered for design of towers located in such sections. The other design parameters such as Reliability level, Terrain category etc, are as per IS:802-2015 and CBIP-2014.

21. Routing of transmission line through protected areas of India shall be avoided to the extent possible. In case, it is not possible to avoid protected areas, the towers of the transmission line up to 400 kV levels which are installed in protected areas shall be designed for Multi-circuit (4 circuits) configuration of same voltage level considering reliability level of at least two (2). The top two circuits of these multi-circuit towers shall be used for stringing of the transmission line under present scope and the bottom two circuits shall be made available for stringing of any future transmission line of any transmission service providers/ State transmission utilities/Central transmission utilities passing through the same protected area.

Further, the configuration and coordinates of such transmission towers shall be submitted to KPTCL and BPC by the TSP.

22. The TSP shall abide by the Guidelines of CEA w.r.t. shifting of transmission lines for NHAI projects and other projects.

23. Safety precautions in regards to gas/oil pipelines in vicinity of Transmission lines shall be taken in coordination with gas/ petroleum authorities.

24. The last span from dead end tower to existing KPTCL substation gantry should be less than 90mtr.

25. In case the LILO of existing line is to be done, and any modification in the existing line is required for the above LILO work the same should be done by the TSP after obtaining necessary approval of KPTCL. Further, the span on either side of LILO points shall be maintained by the TSP.

26. The stringing of the transmission line in forest area shall be carried out through drone.

27. RoW width and Span in different terrain shall be as per Schedule VII of CEA (Technical Standards for Construction of Electrical plants and Electric Lines) Regulations 2022 and RoW guidelines issued vide CEA-PS-14-86/2/2019-PSETD Division dated 24.09.2024.

SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION

The proposed **400/220kV Substation at Ryapte Substation, Pavagada Taluk, tumkur district shall be AIS type & 400/220kV Doddathagalli Substation (near Hoskote), Bengaluru** shall be GIS type generally conforming to the requirements of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022, as amended from time to time.

The proposed extension of 220/66 kV Sarjapura & 220/66 kV Ekrajpura, 400kv Kolar S/s shall be GIS type and 220/66 kV Malur & 220/66kV Hoskote shall be conventional AIS type conforming to the requirements of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022, as amended from time to time..

Note: The technical specifications for bay extension work at Kolar S/s shall be as per PGCIL.

Other CEA Regulations/guidelines as amended up to date and MoP guidelines, as applicable, shall also be followed.

2.1 Salient features of 400/220 kV Sub Station Equipment and Facilities

The design and specification of substation equipment are to be governed by the following factors:

2.2 Insulation Coordination

420kV System would be designed to limit the Switching over voltage to 2.5 p.u and is expected to decay to 1.5 p.u. in 5 to 6 cycles. Consistent with these values and protective levels provided by lightning arrestors, the following insulation levels shall be adopted for 420kV, 245kV and 36 kV systems:

SL No	Description of parameters	400kV System	220kV System	33kV System
1.	System operating voltage (rms)	400kV	220kV	33kV
2.	Maximum voltage of the system (rms)	420kV	245kV	36kV
3.	Rated frequency	50Hz	50Hz	50Hz
4.	No. of phases	3	3	3
5.	Impulse withstand voltage for - Transformer and reactors - for other Equipment - for insulator strings	 1300 kVP 1425 kVP 1550 kVP	 950 kVP 1050 kVP 1050 kVP	 250kVP 170kVP

6.	Switching surge withstand Voltage	1050 kVP	-NA-	-NA-
7.	Minimum creepage distance - for insulator strings - for other Equipment	13020 mm	7595 mm	900 mm
8.	Max. fault current	63 kA	50 KA	31.5 KA
9.	Duration of fault	1 Sec	1 Sec	3 Sec
10.	Corona extinction voltage	320kV rms	156kV rms	NA

2.3 Switching Schemes

It is essential that the system should remain secured even under conditions of major equipment or bus- bar failure. Sub-stations being the main connection points have large influence on the security of the system as a whole. The selection of the bus switching scheme is governed by the various technical and other related factors. One & Half breaker bus scheme for 400kV system and Double Main and Transfer bus scheme for the 220kV system, have been considered for all proposed **AIS** substations and One & Half breaker bus scheme for 400kV system and Double bus scheme for the 220kV system, have been considered for all proposed **GIS** substations under present scope of work due to their merits in terms of reliability, security, operational flexibility and ease of maintenance of equipments. In 400kV substations, each circuit of a double circuit transmission line shall be terminated in different diameter. Similarly, 400kV ICTs shall also be terminated in different diameter. Accordingly, following switching schemes shall be adopted

Voltage / Type of Substation	**400kV side**	**220kV side**
GIS Type	One & half breaker	Double bus scheme
AIS Type	One & half breaker	Double main bus and Transfer bus scheme (DMT)

2.4 Substation Equipment and facilities:

The switch-gear shall be designed to withstand operating conditions and duty requirements. The equipment shall be designed considering the transmission line capacity.

Sl. No	**Description of Bay**	**400kV**	**220kV**
1	Bus Bar	4500A	3500A
2	Line bays	3150A	1600A
3	ICT bays	3150A	1600A (for 400/220kV)
4	Bus Reactor bays	2000A	NA
5	Bus coupler bays	NA/4500A	3500A
6	Transfer Bus Coupler bay	NA	1600A

2.5 Power Transformer

500MVA, 400/220/33kV 3-Phase Auto Transformer shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website.

2.6 Shunt Reactors

125 MVAR, 420 KV, 3-Phase Reactor shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website.

A. **Controlled Switching Device at Bus & Line Reactor**

The controlling relay shall record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

The controller shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified below:

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415V	±10%	50±5%	3/4 Wire	Solidly Earthed
240V	±10%	50±5%	1/2 Wire	Solidly Earthed
220V	190V to 240V	DC	-	Isolated 2 wire system

The controller shall meet the requirements of IEC-60255-4 Appendix 'E' class III regarding HF disturbance test, and fast transient test shall be as per IEC-61000 – 4 level III and insulation test as per 60255 – 5.

2.7 Gas Insulated Switchgear: Refer Technical specification for SF6 gas insulated metal enclosed switchgear (GIS).

2.8 SF6 Circuit Breakers (AIS)

The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-01 and shall be of SF6 Type. The circuit breakers shall be class C2-M2 (as per IEC) with regard to restrike probability during capacitive current breaking and mechanical endurance. The rated break time shall not exceed 40 ms for 400kV circuit breakers and 60 ms for 220kV circuit breakers. 400kV and 220kV Circuit breakers shall be provided with single phase and three phase auto reclosing. The Circuit breakers controlling 400kV lines wherever required shall be provided with pre insertion closing

resistor of about 450 ohms maximum with 8 milliseconds minimum insertion time for lines longer than 200km. The short line fault capacity shall be same as the rated capacity and this is proposed to be achieved without use of opening resistors. 400kV Circuit Breaker shall be equipped with controlled switching device for controlling of transformer and shunt reactor. The controlled switching device shall be provided in 400kV Circuit breakers of switchable line reactor bay and in Main & Tie bay circuit breakers of line with non- switchable line reactors, Bus reactors and ICTs. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Circuit Breakers:

Sl. No.	**Parameter**	**400kV system**	**220kV system**
1.	Rated voltage (Umax) kV (rms)	420	245
2.	Rated frequency (Hz)	50	50
3.	No. of poles	3	3
4.	Type of circuit breaker	SF6 gas insulated	SF6 gas insulated
5.	Rated continuous current at an ambient temperature of 50°. C	3150	3150
6.	Rated short circuit capacity with percentage of DC component as per IEC-62271-100 corresponding to minimum opening time under operating conditions specified.	63kA	50 kA
7.	Symmetrical interrupting capability (rms)	63kA	50 kA
8.	Rated short circuit making current	157.5 kAp	125 kAp
9.	Short time current carrying capability (rms)	63 for one second	50 for one second
10.	Out of phase breaking current carrying capability (rms)	15.75	As per IEC
11.	Rated line charging interrupting current at 90°. Leading power factor angle (rms) (The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/√3 and 1.4 as per IEC-62271-100	600 A	As per IEC
12.	First pole to clear factor	1.3	1.3
13.	Temperature rise over an ambient temperature of 50°C	As per IEC: 62271-100	As per IEC: 62271-100

14.	Rated break time as IEC (with limiting auxiliary voltage at all duties)	40 ms	60 ms
15.	Total break time	40ms	50ms
16.	Total closing time	Not more than 110ms	Not more than 100ms
17.	Operating mechanism or a combination of these	Spring	Spring
18.	Rated operating duty cycle	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO
19.	Reclosing	Single phase &Three phase auto reclosing.	Single phase &Three phase auto reclosing.
20.	Pre-insertion resistor requirement		
i)	Rating (ohms)	400(max.) with tolerance as applicable	NA
ii)	Minimum electrical (mechanical insertion time+pre-arcing time) pre-insertion time (ms)	8	NA
iii)	Opening of PIR contacts	PIR contacts should open immediately after closing of main contacts OR At least 5 ms prior to opening of main contacts at rated air/gas pressure where the PIR contacts remain closed.	NA
21.	Max. difference in the instants of closing/opening of contacts (ms) between poles at rated control voltage and rated operating & quenching media pressures	2.5 (within a pole) 3.3(opening) 5.0 (closing)	3.3(opening) 5.0(closing)
22.	Maximum allowable switching over voltage under any switching condition	2.3 p.u.	As per IEC
23.	Trip coil and closing coil voltage with variation as specified	220V DC	220V DC
24.	Noise level at base and up to 50 m distance from base of circuit breaker	140dB (max.)	140dB (max.)
25.	Rating of Auxiliary contacts	10A	10A
26.	Breaking capacity of Aux. Contacts	10A DC with circuit time constant not less	10A DC with circuit time constant not less than 20ms

		than 20ms	
27.	Rated insulation levels		
i)	Full wave impulse withstand (1.2 /50 µs) between line terminals and ground	±1425 kVp	±1050 kVp
ii)	Full wave impulse withstand (1.2 /50 µs) between terminals with circuit breaker open	1425 kVp impulse on one terminal & 240 kVp power frequency voltage of opposite polarity on the other terminal	±1050 kVp
iii)	Rated switching impulse withstand voltage (250/2500 µs) Dry & wet between line terminals and ground	+1050 kVp .	NA
iv)	Rated switching impulse withstand voltage (250/2500 µs) Dry &wet Between terminals with circuit breaker open voltage of opposite polarity o n the other terminal	900 kVp impulse on one terminal & 345 kVp power frequency	NA
v)	One minute power frequency dry withstand voltage between line terminals and ground	520 kV rms.	460 kV rms.
vi)	One minute power frequency dry withstand voltage between terminals with circuit breaker open	610 kV rms.	460 kV rms.
28.	Minimum corona extinction voltage with CB in all positions	320kV rms	156 kV rrms
29.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz (Micro volts)	1000 µV (at 266kV rms)	1000 µV (at 156kV rms)
30.	Minimum Creepage distance		
i)	Phase to ground (25mm/kV)	13020mm	7595mm
ii)	Between CB terminals	13020mm	7595mm
31.	Rated capacitance current switching duty	C2	C2
32.	Rated Mechanical Endurance duty	M2	M2

2.9 Isolators (AIS)

The isolators shall comply to IEC 62271-102 in general. 400kV& 220kV isolators shall be double break type. All Isolators and earth switches shall be motor operated. Earth switches are provided at various locations to facilitate maintenance. Isolator rated for 400kV & 220kV shall be of extended mechanical endurance class-M2 and suitable for bus transfer current switching duty as per IEC-62271-102 Main blades and earth blades shall be interlocked and interlock shall be fail safe type. 400kV & 220kV earth switch for line isolator shall be suitable for induced current switching duty as defined for Class-B as per relevant standard. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Isolators:

Sl. No.	**Description**	**Unit**	**420kV Isolator**	**245kV Isolator**
1	Rated voltage	kVrms	420	245
2	Rated frequency	Hz	50	50
3	No. of poles	Nos.	3	3
4	Design ambient Temperature	°C	50	50
5	Type		Outdoor, AC Motor Operated	Outdoor, AC Motor Operated
6	Rated current at 50°. C ambient temperature	A	2000A/3150A (as applicable)	1600A/2500A (as applicable)
7	Rated short time withstand current of isolator and earth switch	kA	63 for 1 sec	50 for 1 sec
8	Rated dynamic short time withstand current of isolator and earth switch	kAp	157.5 kAp	125 kAp
9	Temperature rise over design ambient temperature	-	-	-
10	Operating mechanism of isolator/earth switch		A.C. Motor operated	A.C. Motor operated
11	Max. Operating time	secs	20 secs or less	12 secs or less
12	Rated Insulation levels			

a)	Full wave impulse Withstand voltage (1.2/50 microsec.)			
i)	between line terminals and ground	kVp	±1425	±1050
ii)	between terminals with isolator open	kVp	±1425 kVp impulse on one terminal and 240 kVp power frequency voltage of opposite polarity on other terminal	±1200
b)	Switching impulse Withstand voltage (250/2500 micro-second) dry and wet			
i)	between line terminals and ground	kV peak	± 1050	-NA
ii)	between terminals with Isolator open	kV peak	900 kVp impulse on one terminal and 345 kVp power frequency voltage of opposite polarity on other terminal	-NA
c)	One minute power frequency dry withstand voltage			
i)	between line terminals and ground	kV rms	520	460
ii)	between terminals with isolator open	kV rms	610	530
13	Minimum Coro na extinction voltage with Isolator in all positions	kV rms	320	156
14	Max. radio interference Voltage for frequency between0.5 MHz and 2 MHz in all positions	Micro volts	500 at 320 kVrms	500 at 156 kVrms

15	Seismic acceleration		As per	As per
			IS:1893	IS:1893
16	Thermal Rating of Auxiliary Contacts	A	10 A at 220V DC	10 A at 220V DC
17	Breaking Capacity of auxiliary contacts		2 A DC with circuit time constant not less than 20 ms	2 A DC with circuit time constant not less than 20 ms
18	System neutral earthing		Effectively Earthed	Effectively Earthed

2.10 Current Transformers (AIS)

Current Transformers shall comply with IEC 61869. All ratios shall be obtained by secondary taps. Generally, Current Transformers (CT) for 400kV & 220 kV shall have six cores (four for protection and two for metering). The burden and knee point voltage shall be in accordance with the requirements of the system including possible feeds for telemetry. Accuracy class for protection core shall be PS and for metering core it shall be 0.2S. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 20VA for metering core) for better sensitivity and accuracy. The instrument security factor shall be less than 5 for CTs upto 400 kV voltage class. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Current Transformers:

Sl. No.	**Description**	**400kV system**	**220kV system**
1	Rated voltage, Um (kVrms)	420	245
2	Rated frequency (Hz)	50	50
3	No. of Poles	1	1
4	Design ambient temperature (°C)	50	50
5	Rated Primary Current (A)	(i) 3000-2000/1A (ii) 2000-1000-500/1A	(i) 1600-800/1A (ii) 3000-

			2000/1A
6	Rated extended primary Current	125%	125%
7	Rated short time thermal withstand current (kA)	63 for 1 sec	50 for 1 sec
8	Rated dynamic current	157.5 kAp	125 kAp
i)	between line terminals and ground (kVpeak)	±1425	±1050
ii)	between line terminals and ground (kVpeak)	± 1050	-NA-
iii)	between line terminals and ground (kVrms)	630 (dry only)	460
9	No. of Cores	6 (4 nos. for Protection & 2 nos. for metering)	6 (4 nos. for Protection & 2 nos. for metering)

2.11 Capacitor Voltage Transformers (CVT)/Potential Transformers(PT)

Capacitive Voltage transformers shall comply to IEC-61869. These shall have three secondaries out of which two shall be used for protection and one for metering. Accuracy class for protection cores shall be 3P and for metering core shall be 0.2. The voltage transformers on lines shall be suitable for Carrier Coupling. The Capacitance of CVT shall be 4400/8800 pF depending on PLCC requirements. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 100 VA for metering core) for better sensitivity and accuracy. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Capacitor Voltage Transformers:

Sl. No.	**Description**	**420kV CVT**	**245kV CVT**
1	Rated primary voltage (kV rms)	420	245
2	Rated frequency (Hz)	50	50
3	No. of Poles	1	1
4	Design ambient temperature (°C)	50	50
5	System fault level (kA for 1 sec)	63 for 1 sec	50 for 1 sec

6	Standard reference range of frequencies for which the accuracy are valid	96% to 102%for protection and 99% to 101 % for measurement	
7	High frequency capacitance for entire carrier frequency range (for CVT only)	Within 80% to 150% of rated capacitance	
8	Equivalent series resistance over entire carrier frequency range (for CVT)	Less than 40 Ohms	
9	Stray capacitance and stray conductance of HF terminal over entire carrier frequency range (for CVT)	As per IEC-60358	
10	Temperature rise over design ambient temperature	As per IEC-61869	
11	Rated Insulation levels		
a)	Full wave impulse withstand voltage (1.2/50 microsec.)		
i)	Between line terminals and ground	±1425 kVp	±1050kVp
b)	Switching impulse withstand voltage (250/2500 micro-second) dry and wet		
i)	Between line terminals and ground	±1050 kVp	-NA-
c)	One minute power frequency dry withstand voltage		
i)	between line terminals and ground (kVrms)	630 (dry only)	460
d)	One minute power frequency withstand voltage between secondary terminals & earth		
i)	Between LV (HF) terminal and earth terminal (kVrms)	10kV rms for exposed terminals and 4kV rms for terminals enclosed in a weather proof box	
ii)	For secondary winding	3kVrms	
12	Max. radio interference voltage for frequency between0.5 MHz and 2 MHz at (microvolts)	1000 at 266kV rms	1000 at 156kV rms
13	Minimum Corona extinction voltage (kVrms)	320	176
14	Partial Discharge	As per IEC	As per IEC
15	Type	Single phase Electromagnetic or Capacitor VT	
16	No. of secondaries	3 cores	3 cores
17	Rated voltage factor	1.2 - continuous 1.5 - 30seconds	1.2 - continuous

			1.5 - 30seconds
18	Phase angle error	± 10 minutes (For metering core)	± 10 minutes (For metering core)
19	Capacitance (pf) (for CVT)	8800/4400 (+10%/-5%)	8800/4400 (+10%/-5%)
20	Core details	Core-1, Core-2 & Core-3	Core-1, Core-2 & Core-3
a)	Voltage Ratio	Core-1:- (400/√3)/ (0.11/√3) Core-2:- (400/√3)/ (0.11/√3) Core-3:- (400/√3)/ (0.11/√3)	Core-1:- (220/√3)/ (0.11/√3) Core-2:- (220/√3)/ (0.11/√3) Core-3:- (220/√3)/ (0.11/√3)
b)	Application	Core-1:- Protection Core-2:- Protection Core-3:- Metering	Core-1:- Protection Core-2:- Protection Core-3:- Metering
c)	Accuracy	Core-1:-3P Core-2:-3P Core-3:- 0.2	Core-1:-3P Core-2:-3P Core-3:- 0.2
d)	Min. Output burden (VA)	Core-1:- 100VA Core-2:-100VA Core- 3:- 100VA	Core-1:- 100VA Core-2:- 100VA Core- 3:- 100 VA
21	Rated Total Thermal Burden (VA)	300 VA (100 VA/winding)	
22.	Minimum Cantilever Strength	500kg	

2.12 Surge Arresters (AIS)

Station class, heavy duty gapless type Surge arresters conforming to IEC 60099-4 in general shall be provided. The rated voltage of Surge arrester and other characteristics are chosen in accordance with system requirements. Surge arresters shall be provided near line entrances, Transformers & Reactor so as to achieve proper insulation coordination.

Porcelain/Polymer housing if provided for SA shall be fitted with pressure relief devices and diverting ports suitable for preventing shattering of Porcelain/Polymer housing provide path for the flow of rated currents in the event of arrestor failure. A leakage current monitor with surge counter shall be provided with each surge arrestor. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Surge Arresters:

Sl. No.	Description	Unit	420kV SA	245kV SA
1	Nominal System Operating voltage	kV, rms	400	220
2	Rated frequency	Hz	50	50
3	No. of Poles	No.	1	1
4	Design ambient Temperature	°C	50	50
5	Rated arrester voltage	kV	336	198
6	Continuous operating voltage at 50°.C	kV	390	216
7	Nominal discharge current		20 kA of 8/20 microsecond wave	10 kA of 8/20 microsecond wave
8	Discharge current at which insulation co-ordination will be done		20 kA of 8/20 microsecon d wave	10 kA of 8/20 microsecon d wave
9	Minimum discharge capability (referred to rated arrester Voltage) or Corresponding to minimum discharge voltage as per clause-2.0(d) whichever is higher	kJ/kV	12kJ/kV	7kJ/kV
10	Max. switching surge residual voltage	kVp	670 (at 2kA) 650 (at 500A)	500 (at 1kA)
11	Max. residual voltage at			
i)	5kA	kVp	-	560
ii)	10kA nominal discharge current	kVp	800	480

iii)	20kA nominal discharge current	kVp	850	-
12	Cantilever Strength (for 1 minute withstand test)	kg	1000	1000

2.13 Protection & Control

The protective relaying system proposed to be provided for transmission lines, auto-transformers, reactors and bus bars to minimize the damage to the equipment in the events of faults and abnormal conditions, is dealt in this section. All main protective relays shall be numerical type with IEC 61850 (Edition-I &II, site selector) communication interface. All numerical relays shall have built in disturbance recording feature. The auto transformer protection should be provided with two no. differential relays of different make &algorithm.

The protection circuits and relays of transformer and reactor shall be electrically and physically segregated into two groups each being independent and capable of providing uninterrupted protection even in the event of one of the protection groups failing, to obtain redundancy, and to take protection systems out for maintenance while the equipment remains in service.

a) Transmission Lines Protection

400kV and 220kV lines shall have MAIN-I numerical four zones distance protection scheme with carrier aided inter-tripping feature. The fourth zone shall be the reverse zone. 400 kV and 220 kV lines shall also have MAIN-II numerical distance protection scheme like Main-I but from different make that of MAIN-I. However, Line Current Differential relay (with back up distance protection feature) as Main–I & Main-II may be considered, for short lines (line length less than 10 kM) having Fibre Optic communication link for which line differential relay have to be provided for remote end also. In case of loop in loop out of transmission lines, the existing protection scheme shall be studied and suitable up-gradation (if required) shall be carried out. The Main-I and Main-II protection relays of same make may be provided only if they are of different hardware, manufacturing platform or different principle of operation. Associated power & control cabling and integration with SAS at remote end shall be provided by respective bay owner.

All 400kV lines shall also be provided with two stages over voltage protection. Further, all 400kV & 220kV lines shall be provided with single and three phase auto-reclosing facility to allow reclosing of circuit breakers in case of transient faults. These lines shall also be provided with distance to fault locators to identify the location of fault on transmission lines.

Over voltage protection & distance to fault locator may be provided as in-built feature of Main-I & Main- II protection relays. Auto reclose as built in function of

Bay Control Unit (BCU) is also acceptable.

The Main-I and Main-II protection relays shall be fed from separate DC sources and shall be mounted in separate panels. For 400kV and 220kV transmission lines, directional IDMT earth fault relay should be provided as standalone unit or in-built feature of Main-I and Main -II feature.

b) Auto Transformer Protection/Transformer protection:

These shall have the following protections:

(i) Numerical Differential protection
(400/220/11 kV shall have two differential protection relays. The second differential relay shall be provided on IV side C&R panel to avoid congestion on HV side C&R panel. The differential relay shall have different make and algorithm.)

(ii) Numerical Restricted earth fault protection
(iii) Numerical Over-current and earth fault protection on HV & IV side
(iv) Numerical Over fluxing protection on HV & IV side
(v) Numerical Overload alarm
(vi) Neutral displacement

Further, Numerical Back-up Over-current and earth fault protection on HV & IV side of auto- transformer shall not be combined with other protective functions in the main relays and shall be independent relays. Besides these, power transformers shall also be provided with BUCHOLZ relay, protection against high oil and winding temperature and pressure relief device, OSR etc. The auto transformer protection should be provided with two no. differential relays of different make & algorithm.

Suitable monitoring, control (operation of associated circuit breaker & isolator) and protection for LT auxiliary transformer connected to tertiary winding of auto-transformer for the purpose of auxiliary supply shall be provided. The Over current and other necessary protection shall be provided for the auxiliary transformer. These protection and control may be provided as built in feature either in the bay controller to be provided for the auxiliary system or in the control & protection IEDs to be provided for autotransformer.

c) 400 kV Reactor Protection

Reactor shall be provided with the following protections:

(i) Numerical Differential protection.
(ii) Numerical Restricted earth fault protection
(iii) Numerical Back-up impedance protection
(iv) Numeric back up – over current & Earth fault protection

Besides these, reactors shall also be provided with Buchholz relay, protection against oil and winding temperatures & pressure relief device etc.

d) Numerical Bus Bar Protection

The high speed low impedance bus bar differential protection, which is essential to minimize the damage and maintain system stability at the time of bus bar faults, shall be provided for 400kV and 220kV buses. Duplicated bus bar protection is envisaged for 400kV bus-bar protection. Bus bar protection scheme shall be such that it operates selectively for each bus and incorporate necessary features required for ensuring security. The scheme shall have the complete bus bar protection for present as well for present as well as for future bays envisaged i.e. input / output modules for future bays shall also be provided. Bus bar protection system for new substation shall be de-centralized (distributed) type. For existing substations, the existing bus bar protection shall be augmented wherever required.

e) Numerical Local Breaker Back up Protection

This shall be provided for each 400kV and 220kV breakers and will be connected to de-energize the affected stuck breaker from both sides.

2.14 Control Concept

All the EHV breakers in substation/switching stations shall be controlled and synchronized from the switchyard control room and remote control center. Each breaker would have two sets of trip circuits which would be connected to separately fused DC supplies for greater reliability. All the isolators shall have control from remote/local whereas the earth switches shall have local control only.

2.15 Substation Automation System

(a) For all the new substations, state of art Substation Automation System (SAS) conforming to IEC- 61850 (Edition-I & II site selectable) shall be provided. The distributed architecture shall be used for Substation Automation System, where the controls shall be provided through Bay control units. The Bay Control Unit is to be provided bay wise for voltage level 220 kV and above. All bay control units as well as protection units are normally connected through an Optical fibre high speed network. The control and monitoring of circuit breaker, dis-connector, re-setting of relays etc can be done from redundant Human Machine Interface (HMI)

from the Control Room. Additionally IEC 61850 based annunciator system shall be provided for backup.

The functions of control, annunciation, disturbance recording, event logging and measurement of electrical parameters shall be integrated in the Substation Automation System.

At new substations, the Substation Automation System (SAS) shall be suitable for the operation and monitoring of the complete substation including proposed future bays/elements.

In the existing substations with a Substation Automation System (SAS), augmentation of existing SAS shall be done for bays under the present scope.

In the existing Substations where Substation automation is not provided, control functions shall be done through control panels & also interfaced to existing RTU/SCADA.

Necessary gateway and modems (as required) shall be provided to send data to RLDC/ SLDC as per their requirement and shall be provisioned with 2+2 redundancy i.e. 2 channels for Main Control Centre and 2 channels for Backup Control Centre. In order to meet this requirement, suitable redundancy at port and card level need to be ensured by the TSP to avoid any single point of failure which may lead to interruption in real-time grid operation. Accordingly, all the hardware for communication services of station as stated above shall support dual redundancy for data transmission of station to respective main and backup RLDCs. Any augmentation work at RLDC/ SLDC is in TSP's scope. However, all the configuration work at substation end required to send data to RLDC/ SLDC shall be in the scope of TSP.

(b) Time Synchronisation Equipment

Time synchronization equipment complete in all respect including antenna, cable and processing equipment required to receive time signal through GPS or from National Physical Laboratory (NPL) through INSAT shall be provided at new substations. This equipment shall be used to synchronize SAS and IEDs etc.

2.16 Substation Support facilities

Certain facilities required for operation & maintenance of substations as described below shall be provided in new substation. In existing substation, these facilities have already been provided and would be extended/ augmented, wherever required.

2.17 AC & DC power supplies

For catering to the requirements of three phase & single phase AC supply and DC supply for various substation equipment's, the following arrangement is envisaged. However, for substation extension / augmentation, existing facilities shall be augmented as required -

i) For LT Supply at 400/220kV New Substation, one (1) no. 630kVA, 11/0.433kV Transformers shall be provided which shall be connected with 11kV bus of nearby substation and one (1) no. 1MVA, 33/0.433kV on tertiary of 400/220/33kV Auto-transformer. The maximum permissible losses shall be as per Table 6 of IS-1180.

ii) Metering arrangement with Special Energy Meters (SEMs) shall be provided by TSP at 33kV tertiary of Transformer for drawing auxiliary supply at new substation. Such SEMs may be provided by STU at the cost of the TSP. Accounting of such energy drawn by the TSP shall be done by SLDC as part of State Energy Accounting. Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of Transformer by local SEB/DISCOM for energy accounting,

iii) 2 Sets batteries of 220V for control & protection and 2 Sets 48V batteries for PLCC/ Communication equipment shall be provided at each new Substation with at least 10 hours battery backup and extended back up as required. Each battery bank would have a float-cum- boost charger. Battery shall be of plante type.

iv) Suitable AC & DC distribution boards and associated LT Switchgear would be provided at new Substations. Sizing of LT Switchgear shall be suitable to cater the requirement for all present and future bays. AC & DC distribution boards shall have modules for all the present and future feeders as specified.

For Substation Extensions, existing facilities shall be augmented as required. For new substations following switchboards shall be considered with duplicate supply with bus coupler/ sectionalizer and duplicate outgoing feeders except for Emergency lighting distribution board which shall have only one incoming feeder:

(a) 415V Main Switch board – 1 no.
(b) AC distribution board – 1 no.
(c) Main lighting distribution board – 1no.
(d) Emergency lighting distribution board – 1no.
(e) 220 Volt DC distribution board – 2nos.
(f) 48 Volt DC distribution board – 2nos.

415V Main Switch Board & AC distribution board shall be provided with at least two incomers with one bus coupler and AC supply shall have

redundancy.

v) In new Substations, one No. 250 KVA DG set shall be provided for emergency applications.

vi) Sizing of Auxiliary system (like battery, charger, LT switchgear) may be done considering future bay requirements to avoid replacement in future with higher sizes.

2.18 Fire Fighting System

Fire-fighting system in general conforms to fire insurance regulations of India. The fire-fighting system is proposed with both AC motor & diesel engine driven pump house in a fire fighting pump house building along with water storage tank of adequate capacity and oil soak pit of adequate capacity in line with Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022 to drain transformer oil in case of fire or otherwise. Automatic heat actuated emulsifying system to be provided for fire protection of Transformers. However, Nitrogen Injection Fire Protection System (NIFPS) shall be required for 400 kV and 220 kV Class Transformers. In addition, for alarm system based on heat/smoke detectors are proposed to be installed at sensitive points in a substation e.g. Cable Vault, Control Room building and other buildings etc. Further, adequate water hydrants and portable fire extinguishers shall be provided in the substations. The main header of firefighting system shall be suitable for extension to bays covered under the future scope; necessary piping interface in this regard shall be provided.

Optical Beam type heat detection for GIS hall fire protection system shall be provided for all the GIS halls. All fire protection system shall also comply with the requirement of CEA (Measures Relating to Safety & Electric Supply) regulations.

2.19 Oil evacuating, filtering, testing & filling apparatus

To monitor the quality of oil for satisfactory performance of transformers, shunt reactors and for periodical maintenance necessary oil evacuating, filtering, testing and filling apparatus would be provided at new substations. Oil tanks of adequate capacities for storage of transformer oil would be provided.

2.20 Illumination

Normal & emergency AC & DC illumination shall be provided adequately in the control room & other buildings of the substation. The switchyard shall also be provided with adequate illumination.

The entire control room building, fire-fighting pump house, other buildings (if any) and switchyard shall be done by LED based low power consumption luminaries.

2.21 Control Room & GIS Building

Substation control room shall be provided to house substation work station for station level control (SAS) along with its peripheral and recording equipment's, AC & DC distribution boards, DC batteries & associated battery chargers, Fire Protection panels, Telecommunication panels & other panels as per present requirements. Air conditioning shall be provided in the building as functional requirements. Main cable trenches from the control room shall have adequate space provision for laying of cables from control room for all the future bays also. Modular multidiamter cable sealing system which is water proof, fire proof, rodent proof wherever the control cable/Power cable/Instrumentation cable enter or leave the control room, shall be provided.

2.22 PT Distribution Scheme

A suitable PT distribution scheme for 400kV & 220 kV has to be provided by TSP. TSP may visit the existing Sub-Stations in order to familiarize themselves with the existing system. The PT distribution board must be suitable for distributing the main bus PTs to all the feeder/transformers. The Potential transformers shall comply with the relevant codes/standards. The number of secondary cores, accuracy class and burden shall be in accordance with the requirements of the protection and metering system. Rated burden shall be nearest to the burden computed; however it shall not exceed 100 VA. The accuracy class for metering core shall be equal to or better than the accuracy class of the meter specified in the Central Electricity Authority (Installation and Operation of Meters) Regulations.

2.23 Phasor Measurement Unit (PMU)

The substations are provided with CTs on each bay of the switchyard and CVTs/PTs in each transmission line bay and on each bus. The CTs have one metering core and four protection cores. The CVTs are provided with three cores for metering/protection. The offered Phasor Measurement Unit (PMU) shall be connected to either of these CT and CVT cores. PMUs shall be suitable for measurement on both the cores (Meter & Protection).

The PMUs to be installed at the Substations / Power stations, shall communicate to the existing Phasor Data Concentrator (PDC) installed at SLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard or IEC/IEEE 60255-118-1:2018 Standard with all amendments. PMU complying IEC/IEEE 60255-118-1:2018 Standard shall be preferred. The PMU shall be capable of reporting with its full features to the existing PDC installed at SLDC under the Unified Real Time Dynamic State Monitoring (URTDSM) Project. The PMU’s are to be provided for each feeder bays and transformers in 400kV substations and the data is to be transferred through single channel to SLDC.

3.0 GENERAL FACILITIES

Following facilities shall be provided:

- Substation Gantry/Towers are envisaged for present scope of bays only. However, for adjacent future bay, gantry/towers shall be designed for extension (considering Quad conductor for 400kV future lines, Single/Double conductor for 220kV future lines) wherever required.
- The sub-station shall be confirming to the requirement of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022, as amended from time to time.
- In addition, the scope for development of communication system at the Substations & Transmissions lines is in the scope of TSP. The communication equipment at both ends of the transmission line terminating at KPTCL's substation, along with its O&M, shall be in the scope of the TSP. For all the new substations, PLCC, Substation Automation System (SAS) & Time synchronization equipment, shall be provided by the TSP as per guidelines & amendments thereof.
- Bay extension works at existing substation shall be executed by TSP in accordance with the requirements/provisions mentioned above. However, interface points shall be considered keeping in view the existing design/arrangement at the substation.
- TSP has to arrange for construction power and water on its own.
- Space for storage of O&M spares shall be arranged by TSP on its own.
- Boundary wall shall be brick masonry wall with RCC frame or Stone masonry wall or Precast RCC wall under present scope along the property line of the complete substation area including future switchyard area to prevent encroachment and unauthorized access. The minimum height of the boundary wall shall be of 1.8 m from finished ground level (FGL).
- All electrical equipment shall be installed above the Highest Flood Level (HFL) and where such equipment is not possible to be installed above Highest Flood Level, it shall be ensured that there is no seepage or leakage or logging of water.

EXTENSION OF EXISTING SUBSTATION

The following drawings/details of existing substation are attached with the RfP documents for further engineering by the bidder.

Sl. No.	Drawing Title	Drawing No./Details	Rev. No.
A.	**220 kV Malur substation**		
1.0	Single Line Diagram	KPTCL/TECH/SS-220/MLR 1	
2.0	Layout Plan		
3.0	Cross Section	KPTCL/TECH/SS-220/MLR 3	
4.0	Earthmat Layout	SEE/R&D/F19(1)	
B.	**220kV Ekarajapura substation**		
1.0	Single Line Diagram	KPTCL/TECH/SS-220/HKT-1/R2	
2.0	Layout Plan	KPTCL/TECH/SS-220/BNK-4/R2	
3.0	Cross Section	KPTCL/TECH/SS-220/BNK-5/R2	
4.0	Earthmat Layout	SEE/R&D/F4 (1)	
C.	**220kV Sarjapura substation**		
1.0	Single Line Diagram	KPTCL/TECH/SS-220/SJP-1	
2.0	Layout Plan	KPTCL/TECH/SS-220/SJP-4	
3.0	Cross Section	KPTCL/TECH/SS-220/SJP-5	
4.0	Earthmat Layout	SEE/R&D/F9(8)	

Note: The existing drawings provided above and in subsequent amendments to the RfP are as received from the developer of existing substation and provided only for reference. Bidders shall follow the RfP for scope of work. Actual site conditions may be different due to other schemes being executed or subsequent revisions by the developer. Therefore, Bidders are advised to visit the substation sites and acquaint themselves with the actual site conditions, layout, topography, infrastructure such as the requirement of roads, cable trench, drainage, boundary etc. and also the design philosophy.

Details of existing substation								
S. no	**From**	**To**	**Capacity available in LT transformer**	**Spare feeder in ACDB**	**Spare feeder in DCDB**	**Battery capacity**	**Availability of Busbar protection**	**Availability of fire hydrant system**
1	Prop.400/ 220 kV Doddathagalli S/s	Ex. 220 kV Malur S/s	Available	Available	Available	Available	Available	NA
2		Ex. 220 kV Ekrajapura S/s	Available	ACDB with 1 I/C and 5 feeders required	Available	Available		
3		Ex. 220 kV Sarjapura S/s	Available	ACDB with 1 I/C and 5 feeders required	DCDB with 2 I/C and 6 feeders required	Available	Available	NA

TECHNICAL SPECIFICATION FOR SF6 GAS INSULATED METAL ENCLOSED SWITCHGEAR (GIS)

1.0 GENERAL CHARACTERISTICS

The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of it's live constituent parts. It should be designed for indoor/outdoor (as specified) application with meteorological conditions at site as per Section Project. All parts of the switchgear should be single phase enclosed for 400 kV and single phase/three phase enclosed for 220 kV.

The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make on either end without any drilling, cutting or welding on the existing equipment. To add an equipment, it shall not be necessary to move or dislocate the existing switchgear bays. As the 400/220kV GIS is likely to be extended in future on either side, the contractor shall make available during detailed engineering stage, all details such as cross section, gas pressure, extension conductor piece to extend existing bus bar and all required material etc. for design of adopter in future for extension of GIS. GIS must be complete in all respects for future extension and there should be no requirement of any component/material of GIS from the present supplier at the time of future extension by another GIS manufacturer.The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included. The required overall parameters of GIS are as follows :-

Sl. No.	Technical particulars	400 kV System	220 kV System
a	Rated Voltage	420 kV (rms)	245 kV (rms)
b	Rated frequency	50 HZ	50 HZ
c	Grounding	Effectively earthed	Effectively earthed
d	Rated power frequency withstand Voltage (1min) line to earth	650 kV (rms)	460 kV (rms)
e	Impulse withstand BIL (1.2/50/mic. Sec) Line to earth	±1425 kVp	±1050 kVp
f	Switching impulse voltage (250/2500 mic.-sec)	1050 kVp	-
g	Rated short time withstand current (1 sec)	63/50/ 40 kA (rms) (As applicable)	50/ 40 kA (rms) (As applicable)
h	Rated peak withstand	157.5/125/100	125/100

Sl. No.	Technical particulars	400 kV System	220 kV System
	current	kA (peak) (as applicable)	kA(peak) (as applicable)
i	Guaranteed maximum gas losses for complete installation as well as for all individual sections in %	As per IEC-62271-203	As per IEC-62271-203
j	Rated current normal/ at site (at 50 degree C design ambient temperature)	As per schedule of requirement	As per schedule of requirement
k	Seismic level	Zone – II as per IS-1893, Year-2002	Zone – II as per IS-1893, Year-2002

The metal-enclosed gas insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the IEC-62271-203 publications including their parts and supplements as amended or revised to date.

2.0 REFERENCE STANDARDS

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC)
Publications including their parts and supplements as amended or revised to date:

IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above 52KV
IEC 60376	New sulphur hexafluoride
IEC 62271-	100 High voltage alternating current Circuit breakers
IEC 62271-1	High voltage Switchgear and control-gear standards – common specifications
IEC 62271-102	Alternating current disconnectors(isolators) and earthing switches
IEC 61128	Alternating current disconnectors. Bus-transfer current switching by disconnectors.
IEC 61129	Alternating current earthing switches. Induced current

	switching
IEC 61869-2/1	Current transformers
IEC 61869-3/1	Voltage transformers
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 62271-209	Cable connections for gas-insulated metal enclosed switchgear for rated voltage above 52kV
IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099 -1/4	Non-linear resistor type arresters for AC systems
IEC 60439	Factory-built assemblies of low-voltage switchgear and control Gear.
IEC 62271-101	High-voltage Switchgear & control gear – synthetic test.
IEEE 80 (2000)	IEEE Guide for Safety in AC Substation grounding.
CIGRE-44	Earthing of GIS- an application guide. (Electra no.151,Dec'93).
IEC 61639	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

The components and devices which are not covered by the above standards shall conform to, and comply with, the latest applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer. The manufacturer shall list all applicable standards, codes etc. and provide copies thereof for necessary approval.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

3.0 DEFINITIONS

3.1 Assembly

Assembly refers to the entire completed GIS equipment furnished under contract.

3.2 Bay

Bay refers to the area occupied by one Circuit Breaker and associated equipments used to protect one line/transformer/Reactor/bus coupler in double bus scheme/one and half breaker scheme and which comprises of atleast one circuit breaker, two disconnectors & 3 Nos. of single phase CT's/bushing CT's.

3.3 Compartment

When used in conjunction with GIS equipment, compartment refers to a gas tight volume bounded by enclosure walls and gas tight isolating barriers.

3.4 Enclosure

When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal Power system equipment (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer surge arresters, interconnecting bus etc.)

3.5 Manual Operations

Manual operation means operation by hand without using any other source of Power.

3.6 Module

When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for example, a module can contain a disconnecting switch and a grounding switch.

3.7 Reservoir

When used in conjunction with GIS equipment reservoir refers to a larger gastight volume.

4.0 GENERAL DESIGN AND SAFETY REQUIREMENT

4.1. The GIS assembly shall consist of separate modular compartments e,g Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life,

allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions ,thus providing controlled pressure relief in the affected compartment.

4.2. The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

4.3. The switchgear, which shall be of modular design, shall have complete phase isolation. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is atleast 5 % greater than the rated voltage .They should be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

4.4. Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.

4.5. Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. They shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced, it should be ensured by the bidder that adjacent compartment would remain in service and also isolate/earth the gas compartments which is not at minimum operating pressure. The gas tight barriers shall be clearly marked on the outside of the enclosures. The service continuity of GIS shall confirm to Annexure-F of IEC :62271-203.

4.6. The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period as specified in IEC at rated short time withstand current. The material shall

be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition.

4.7. Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment. Inspection windows shall be provided for disconnector and earth switches.

4.8. The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.

4.9. Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

4.10. The manufacturer shall guarantee that the pressure loss within each individual gas-filled compartment shall not be more than half percent (0.5%) per year.

4.11. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

4.12. The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

4.13. The thermal rating of all current carrying parts shall be minimum for one

sec. for the rated symmetrical short-circuit current.

4.14. The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas-proof compartments preferably for:

a) Bus bars

b) Intermediate compartment

c) Circuit breakers

d) Line disconnectors

e) Voltage Transformers

f) Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.

g) Gas Insulated bus section between GIS & Oil filled Transformer/ Reactor

The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnector (when bus and bus disconnector are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus. The design of GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate number of intermediate compartments, if required, shall be provided to ensure equipment and operating personnel's safety. The service continuity of GIS shall confirm to Annexure-F of IEC :62271-203.

4.15. The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.

4.16. The layout of the substation equipment ,busbars and switchgear bays shall preferably be based on the principle of _ phase grouping _ . Switchgear layout based on the _ mixed phases _ principle shall not be accepted without mutual agreement between supplier and owner. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance.

4.17. LOCAL CONTROL CUBICLE (LCC)

4.17.1. Functions

4.17.1.1 Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore/indicating lamp for status indication of the circuit-breaker and all associated isolators and earth switches together with selector switches to prevent local and remote and supervisory controls being in operation simultaneously.

4.17.1.2. Status indications in the LCC shall be semaphore type or LED type.

4.17.1.3. Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under

Technical Specification Gas Insulated Switchgear Page 37 of 80 Rev 05 (April 2018) maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.

4.17.1.4. If Disconnector or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.

4.17.1.5. 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control, alarms, indications, protection and main power supply etc .

4.17.1.6. Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged. In plug in connector type cable arrangement, min 2 cores of the cable with connected condition on both side up to the TB to be left unused as spare.

4.17.1.7. Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.

4.17.1.8. LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS

4.17.2. **Constructional features**

4.17.2.1. Local Control cubicle shall be either mounted on the GIS with front access or free standing, floor mounting type. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation. Alternatively folded sheet panels of adequate thickness and strength is also acceptable.

4.17.2.2. Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers (if required) having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM/PU gaskets conforming to the provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors.

4.17.2.3. For LCC panel of each feeder bay (i.e. line, transformer, and reactor etc.), Bus Coupler bay and Bus Sectionalizer bay, separate AC/DC supply for power circuit of GIS switchgear shall be provided, fed directly from ACDB/DCDB. The control DC supply (for control, interlocking, signaling) shall be tapped from respective relay & protection panel. For LCC panel illumination and heating purpose Loop in Loop out AC Supply can be provided.

4.17.2.4. Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses/MCBs. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse Technical Specification Gas Insulated Switchgear Page 38 of 80

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bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.

4.17.2.5. Each LCC Panel shall be provided with the following

1. **Plug Point**: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5/15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

2. **Interior Lighting**: Each panel shall be provided with a door-operated LED lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.

3. **Space Heater**: Each panel shall be provided with a thermostatically connected space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

4.17.2.6. Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles.

4.17.2.7. The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e. installed behind a lockable glass door, that allows a complete view of the annunciator and mimic diagram when the LCC door is closed. Necessary protection shall be provided to avoid inadvertent operation of control switches.

4.17.2.8. An interlocking scheme shall be provided that takes into account the following basic requirements.

I. To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.
II. prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.

4.17.2.9. Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked/handle lock, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

4.17.2.10. Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency tripping device shall be kept separate and distinct from the key interlocking.

4.17.2.11. Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made Technical Specification Gas Insulated Switchgear Page 39 of 80 Rev 05 (April 2018) possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

4.17.2.12. Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.-

4.17.2.13. All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.

4.17.3 Cabling between LCC Panel and GIS equipment

4.17.3.1. The unarmored screen cable shall be of 1.1kV grade, multi core, annealed copper conductor, Tinned copper braided screen (approx. 85% coverage).

4.17.3.2. The core insulation and outer sheath of cable shall be of halogen-free special polymer.

4.17.3.3. The cable shall be flame-retardant, flexible, abrasion-and wear-resistant.

4.17.3.4. The size of core shall not be less than 2.5 sq. mm for instrument transformers and 1.5 sq.mm for other control cable.

4.17.3.5. Prefabricated cables with heavy duty multi-point plug-in connections on GIS end shall be provided.

4.17.3.6. All instrument transformer connections shall be hard wired to terminal block via ring type connection.

The LCC panel as a separate item may be considered if the bidder desires to supply from the manufacturer other than GIS supplier. The make of LCC panel shall be KPTCL approved C&R panel vendors make only. Also, the interfacing of LCC panel with original GIS module in respect of schemes, TB nos, Ferrule nos etc., is in the scope of Bidder

The supply of power and control cables and cabling from GIS module up to Local Control Panels shall be in GIS module supplier/BIDDER's scope.

4.18. All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure parts, or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.

4.19. It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.

4.20. In case of any repair or maintenance on one busbar disconnectors, the other busbar should be live and in service.

4.21. All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they can not be operated easily, i.e. the operator must use tools or brute force to over-ride them.

4.22. In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

4.23. The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, Year- 2000 . The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

4.24. The fabricated metal enclosures shall be of Aluminium alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.

4.25. The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies. The removed interrupter assembly

must be easily and safely accessible for inspection and possible repairs.

4.26. The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamic stresses even under short circuit conditions.

4.27. The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

4.28. The Average Intensity of electromagnetic field shall not be more than 50 micro –Tesla on the surface of the enclosure. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.

4.29. The Bidder shall furnish the following information regarding the loosely distributed metallic particles within the GIS encapsulation.

a) Calculations of critical field strength for specific particles of defined mass and geometry.

b) The methodology and all the equipment for electrical partial discharge (PD) detection including that mentioned in the specification else-where.

4.30. The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

4.31. The ladders and walkways shall be provided wherever necessary for access to the equipment. A portable ladder with adjustable height may also be supplied to access to the equipment.

4.32. Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 240V AC supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phsase. 4-wire load. The possibility of using heaters without thermostats in order to achieve the higher reliability may be examined by the bidder and accordingly included in the offer but it shall be ensured by the bidder that the temperature rise of different enclosures where heating is provided should be within safe limits as per relevant standards. One copy of the relevant extract of

standard to which the above arrangement conforms along with cost reduction in offer. If any, shall also be furnished along with the offer. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

4.33. The enclosure & support structure shall be designed that a mechanic 1780 mm in height and 80 Kg in weight is able to climb on the equipment for maintenance.

4.34. The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

4.35. Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

4.35.1. Gas Insulating System:

a) Loss of Gas Density.

b) Loss of Heater power(if required)

c) Any other alarm necessary to indicate deterioration of the gas insulating system.

4.35.2. Operating System:

a) Low operating pressure.

b) Loss of Heater power.

c) Loss of operating power.

d) Loss of control.

e) Pole Disordance.

4.36. The equipment will be operated under the following ambient conditions:

a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.

b) The humidity will be about 95% (indoors)

c) The elevation is less than 1000 metres.

4.37. Temperature rise of current carrying parts shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions at site. The temperature rise for accessible enclosure shall not exceed 20 degree C above the ambient temperature of 50 degree C. In the case of enclosures, which are accessible but need not be touched during normal operation, the temperature rise limit may be permitted upto 30 degree C above the ambient of 500 C.

These conditions shall be taken into account by the supplier in the design of the equipment.

5.

5.1 Type tests The offered 400/220kV GIS equipments shall conform to the type tests as per IEC-62271-203.

The type tests certificates should not be older than Ten (10) years as on the last date of submission of bid.

a) For equipments manufactured in India:

i. Type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by Government or accredited by National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.

ii. Type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.

iii. The type tests conducted in-house by manufacturers shall also be acceptable provided the lab (manufacturer's) is accredited by National accreditation body of the country and the tests have been witnessed by a representative of NABL accredited Independent laboratory/Power utility.

b) For equipments manufactured Abroad:

i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of respective country.

ii. Type tests conducted in-house by manufacturers shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests have been witnessed by a representative of accreditation body / Power utility.

Contractor shall submit type test reports for the following type tests & additional type tests.

Sl. No.	Description of the Type Test for 400kV and 220kV GIS
1	Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3	Tests to prove the ability of the main and Earthing circuits to carry the rated peak and rated short time withstand current.
4	Tests to verify the making and breaking capacity of the included switching devices.
5	Tests to prove the satisfactory operation of the included switching devices
6	Tests to prove the strength of the enclosures
7	Gas tightness tests
8	Tests on partitions
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on insulators
13	Additional tests on auxiliary and control circuits
14	Tests to prove the radio interference voltage (RIV) level (if applicable)
15	Electromagnetic Compatibility Test (EMC)
16	Reactor current switching test.
17	Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure [ref clause No. 11.4(vi)]

The test reports of the above type tests for GIS as well as all type tests on 400kV SF6/ Air bushing as per IEC 60137 shall be submitted for approval as per section-GTR of Technical specification.

5.2: **Routine Tests:**

a) Routine tests shall be made either in the course of component assembly and / or on the complete shipping unit assembly.

The following routine tests shall be performed as per IEC 62271-203 at the factory on every unit following its manufacture:

i. Dielectric test on the main circuit.
ii. Tests on auxiliary and control circuits
iii. Measurement of the resistance of the main circuit.
iv. Tightness test.
v. Design and visual checks.
vi. Pressure tests of enclosures.
vii. Mechanical operation tests.
viii. Tests on auxiliary circuits, equipment and interlocks in the control mechanism.
ix. Pressure test on partitions.

Note: Tests on transport units.
GIS modules or components shall be assembled in the factory to transport units. The size of the transport units shall be defined by engineering and shall be as large as practical for shipment to the site and handling during installation. On assembly units without support or barrier insulator dielectric tests are not necessary.

5.3 KPTCL may insist for conducting all or some of the routine tests at the factory premises during inspection of the GIS module by KPTCL Engineers.

5.4 Tests after installation on site:

After the switchgear has been completely installed on site & filled with SF6 gas, the complete assembly shall be subjected to the following site test as per IEC: 62271-203.

a) Dielectric tests on the main circuit.
b) Dielectric tests on auxiliary circuit.
c) Measurement of the resistance of the main circuit.
d) Gas tightness tests.
e) Checks and verifications.
f) Gas quality verifications.
g) ON SITE HV TESTINGS.

6. Bellows or Compensating Units :-

Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The bellows shall be metallic (preferably of stainless steel) of following types or other suitable equivalent arrangement shall be provided wherever necessary.

1. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.
2. Axial compensators:These shall be provided to accommodate changes in length of busbars due to temperature variations.
3. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
5. Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.
6. The electrical connections across the bellows or compensating units shall be made by means of suitable connectors.

7. INDICATION AND VERIFICATION OF SWITCH POSITIONS

Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main cntact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment. Windows shall also be provided with all isolators and earthswitches so that the switch contact positions can be verified by direct visual inspection.

8. PRESSURE RELIEF

Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction). Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms.

9. PRESSURE VESSEL REQUIREMENTS

The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel) Each enclosure has to be tested as a routine test at 1.5 time the design pressure for one minute. The bursting strength of Aluminium castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

10. EARTHING:

10.1 The MANUFACTURER shall provide a “Main Ground Bus Earth mat”, rated 63kA/50kA for 3 sec (as required)., to which all intentionally earthed parts of the assembly must be connected.

10.2 It shall be the responsibility of the VENDOR to provide a sufficient number of earth points so that dangerous voltages are not induced in the enclosure by the fault currents circulating in the inner conductor.

10.3 Earthing pads shall be provided for at-least two paths to earth from the “Main Earth Bus” or each metallic enclosure and auxiliary equipment designated for connection to the station earth grid. The VENDOR shall provide data to assure that the connections from the “Main Earth Bus” to the station earth will not interfere with required enclosure current paths or any operational feature of the assembly. A copper earth bar, located near the control cable entrances of all main and auxiliary equipment, shall be provided for the purpose of terminating the shield of each control cable.

10.4 Provision shall be made for future extension and/or connection to earth buses of other interconnecting switchgear.

10.5 The BIDDER shall be responsible for supplying all earthing materials required for bonding all the equipment and steel work included in this contract to the main station earth mat also to be provided by the BIDDER.

10.6 The design of the earth system and connection to the switchgear equipment shall also be compatible with the circulating currents that are present in the switchgear metal cladding. On the design of the earth mat mesh, the VENDOR shall provide full details of the circulating currents expected to flow in the earth mat system.

10.7 Every section of the SF6 switchgear equipment including all panels, cubicles, kiosks and boxes shall be solidly bonded to the earthing system.

10.8 Earth switches, voltage transformers, panels and kiosks, shall be bonded to the earthing system as specified in the relevant previous clauses.

10.9 All steelwork, access decking and gangways, handrails, etc., shall also be effectively bonded to the earthing system.

10.10 The design of the earthing system along with the station earth mat shall be such as to ensure the safety and protection of all operating and maintenance personnel under all normal and fault conditions. Detailed earthing drawings shall be prepared for the complete installation which shall be provided under this contract and submitted to the PURCHASER for approval.

10.11 The enclosure of the equipment and support structure of GIS shall be earthed in such a way that the following conditions are obtained:

a) The touch potential at any part of the enclosure is less than 65 V.
b) The induced current during normal operation is prevented from entering the earthing grid.

10.12 GIS Module earth mat has to be provided by the bidder for which detailed calculation and drawings to be furnished.

10.13 GROUNDING

The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences. The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The GIS supplier must supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The GIS supplier is also required to supply all the earthing conductors and associated hardware material for the following:

1) Connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS.

2). The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of

grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with Cu/ Al bonds of suitable size to bridge the flanges. In case the bidder does not offer external bonding, the bidder shall demonstrate that the connectivity offered by them between each enclosure is effective and does not require external bonding. Further similar design should have been in service. Subassembly to subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

Each marshalling box, local control panel, power and control cable sheaths and other non current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures. The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, ph./ earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/ counter discontinued SF6/ Air termination, SF6/ Transformer or Reactor termination, SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

11. CIRCUIT BREAKERS

11.1 General

SF6 gas insulated metal enclosed circuit breakers shall comply with the latest revisions of IEC- 62271-100 & relevant IEC except to the extent explicitly modified in the specification and shall meet with requirements specified.

Circuit breakers shall be equipped with the operating mechanism. Circuit breakers shall be of single pressure type. Complete circuit breaker with all

necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing with an operating sequence and timing as specified.

11.2. Duty Requirements

Circuit breaker shall be C2 - M2 class as per IEC 62271-100.

Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on 400/220 kV effectively grounded system, with transmission lines of lengths and characteristics as indicated in Section Project and perform make and break operations as per the stipulated duty cycles satisfactorily.

11.3 PRE INSERTION RESISTER

400 kV circuit breakers for line bay shall be provided with single step pre insertion closing resistors (wherever the requirement of PIR is explicitly specified so) to limit the switching surges to a value of less than 2.3 p.u. The value of the pre-insertion resistor and the duration of pre-insertion time shall be as given in clause 10.7.3 of this chapter. The resistor shall have thermal rating for the following duties :

i) TERMINAL FAULT

Close .... 1 Min ..... Open ..... Close open 2 min ..... close ..... 1 Min ..... open close open.

ii) RECLOSING AGAINST TRAPPED CHARGES

Duty same as under (i) above. The first, third and fourth closures are to be on de-energised line while second closing is to be made with lines against trapped charge of 1.2 p.u. (Based on 1 pu = 653kV) of opposite polarity.

iii) OUT OF PHASE CLOSING

One closing operation under phase opposition that is with twice the voltage across the terminals.

iv) No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Calculations and test reports of resistors proving thermal rating for duties specified above shall be furnished alongwith the bid. The calculations shall take care of adverse tolerances on resistance values and time settings.

11.4. The circuit breaker shall be capable of:

i) Interrupting the steady and transient magnetizing current corresponding to 400 kV/220 kV class transformers of 500MVA ratings on both 400 kV & 220 kV side.

ii) Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors.

iii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

iv) Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

v) The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges.

vi) Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (ie., 2 p.u. across the breaker continuously, for validation of which a power frequency dielectric withstand test conducted for a duration of at least 15 minutes is acceptable).

vii) 400 kV breakers shall be able to switch in and out the 400 kV shunt reactor for any value from 50 MVAR up to 80 MVAR without giving rise to overvoltage more than 2.3 p.u. Laboratory test and or field test reports in support of the same shall be furnished along with the bid.

11.5 Controlled Switching Requirements:

The circuit Breaker shall be equipped with controlled switching with consequent optimization of switching behavior when used in switching of 400kV Bus reactor & switchable Line reactor. The controller shall be provided in Main & Tie circuit breakers of Bus reactors.

The controlling relay shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

11.5.1 Technical Requirement for controlled switching device:

1. The controller shall be designed to operate at the correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified in section – GTR.

2. The controller shall meet the requirements of IEC-60255-4 Appendix ‘E’ class

III regarding HF disturbance test and fast transient test shall be as per IEC-61000-4 level III and insulation test as per 60255-5.

3. The controller shall have functions for switching ON & OFF the circuit breakers.

4. The controller shall get command to operate the breakers manually or through auto reclose relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

5. The controller shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of next operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, hydraulic/pneumatic pressure of the operating mechanism, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than + 0.5ms.

6. The controller should have display facility at the front for the settings and measured values.

7. The controller should be PC compatible for the setting of various parameters and down loading of the settings and measured values date time of witching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.

8. The controller shall have self-monitoring facility.

9. The controller shall be suitable for current input of 1 amp from the secondary of the CTs and 110V (ph to ph) from the CVTs. The controller shall also take care of transient and dynamic state values of the current from the secondary of the CTs and CVTs.

10. The controller shall have time setting resolution of 0.1ms or better

11. The controller shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

11.6 Total Break Time

The total break time shall not be exceeded under any of the following duties :

i) Test duties T10,T30,T60,T100 (with TRV as per IEC- 62271-100)

ii) Short line fault L90, L75 (with TRV as per IEC-62271-100)

iii) The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), pneumatic/hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the bidder may specifically bring out the effect of non simultaneity between poles and show how it is covered in the total break time. The values guaranteed shall be supported with the type test reports.

11.7. CONSTRUCTIONAL FEATURES

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

11.7.1. Contacts

All making and breaking contacts' shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

11.7.2. Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

11.7.3. Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

11.7.4. The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 pu. power frequency voltage across the breaker continuously)

11.7.5. In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.

11.7.6. Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site.

11.8. OPERATING MECHANISM

11.8.1. General Requirements:

a) Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these. The mechanism shall be housed in a dust proof cabinet and shall have IP : 42 degree of protection.

b) The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.

c) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be antipumping and trip free (as per IEC definition) under every method of closing.

d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet/operating Mechanism.

f) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

g) The bidder shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker.

11.8.2. Control

a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

b) Each breaker pole shall be provided with two (2) independent tripping circuits, valves, pressure switches, and coils each connected to a different set

of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker central control cabinet.

d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.

f) Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissives in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuit shall be monitored and for remote annunciations and operation lockout in case of dc failures.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

11.8.3. Spring operated Mechanism

a) Spring operated mechanism shall be complete with motor in accordance with Section GTR. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the

closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 60 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

11.8.4. Hydraulically Operated Mechanism :

a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor etc.

b) The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.

c) The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate no. of spare contacts, for continuous monitoring of low pressure, high pressure etc. at switchyard control room.

d) The mechanism shall be suitable for at-least two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.

e) The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up.

f) Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for lost of Nitrogen shall also be provided.

g) All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage.

11.9. ADDITIONAL DATA TO BE FURNISHED ALONGWITH THE OFFER:

a) Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

c) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.

11.10. TESTS

11.10.1. In accordance with the requirements stipulated under Section GTR the circuit breaker alongwith its operating mechanism shall conform to the type tests as per IEC-62271-100.

11.10.2. Routine Tests

Routine tests as per IEC : 62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer alongwith necessary transducers, cables, console etc. shall be furnished as mandatory maintenance equipment.

11.10.3 TECHNICAL PARAMETERS:

400 kV CIRCUIT BREAKER:

a)	Rated voltage kV (rms)	420
b)	Rated frequency (Hz)	50
c)	No. of poles	3
d)	Type of circuit breaker	SF6 insulated.
e)	Rated continuous current (A) at an ambient temperature of 50^0C	3150/4000 A (for line, transformer & Reactor, bus coupler bay breaker)
f)	Rated short circuit capacity	63kA/50kA with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions as specified
g)	Symmetrical interrupting capability kA (rms)	63kA/50kA
h)	Rated short circuit making current kAp	157.5kA/125kA
i)	Short time current carrying capability for Three second kA (rms)	63kA/50kA
j)	Rated line charging interrupting current at 90 degree leading power factor angle (A rms)	As per IEC
	(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/√3 and 1.4 as per IEC-62271-100	
k)	First pole to clear factor	1.3
l)	Rated break time as IEC (ms)	40
m)	Total break time (ms)	45
n)	Total closing time (ms)	Not more than 150
o)	Rated operating duty cycle	O-0.3s –CO-3 min-CO
p)	Reclosing	Single phase & Three phase auto reclosing.
q)	Pre-insertion resistor requirement (If required) 1). Rating (ohms) 2). Minimum pre-insertion Times (ms) 3). Opening of PIR contacts	400 8 a) PIR contacts should open immediately after closing of main contacts. b) Atleast 5 ms before opening of main contacts at rated air/gas pressure, where the PIR contact remain closed.
r)	Rated insulation levels Full wave impulse withstand (1.2x50micro sec.)	
	Between lines terminals and ground:	±1425 kVp
	Between terminals with	±1425 kVp impulse on one terminal & 240kVp of

	circuit breaker open:	opposite polarity on the other terminal.
s)	Rated switching impulse withstand voltage (250/2500 micro-sec) Dry & wet. Between terminals with circuit breaker open:	1050kVp ±900 kVp impulse on one terminal & 345kVp of opposite polarity on the other terminal.
t)	One minute power frequency withstand voltage. • Between line • terminals and ground • Between terminals with circuit breaker open.	650kV rms. 815kV rms.
u)	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 266kV(Micro volts)	1000
v)	Max. difference in the instants of closing/opening of contacts (ms) between poles.	As per IEC
w)	Trip coil and closing coil voltage	220V DC with variation as specified in Sec GTR
x)	Auxiliary contacts Auxiliary switch shall also comply with requirements as given. Independent single pole reversible contacts (from NO to NC & vice versa.	Each circuit breaker pole shall be provided with an auxiliary switch with 20% of spare – NO & 20% spare NC contacts for use in future.
y)	Rating of auxiliary contacts Breaking capacity of auxiliary contacts less than 20 ms. System neutral earthing	10A at 220V DC 2A DC with the circuit time constant of not less than 20ms. Effectively earthed.
z)	Mechanical & Electrical endurance class	M2-C2

245 kV CIRCUIT BREAKER:

a)	Rated voltage kV (rms)	245
b)	Rated frequency (Hz)	50
c)	No. of poles	3
d)	Type of circuit breaker	SF6 insulated.
e)	Rated continuous current (A) at an ambient temperature of 40^0C	1600/3000 A (3000 for bus coupler breaker)

f)	Rated short circuit capacity	50/40kA (As applicable) with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions as specified
g)	Symmetrical interrupting capability kA (rms)	50/40 kA(As applicable)
h)	Rated short circuit making current kAp	125/100kA(As applicable)
i)	Short time current carrying capability for Three second kA (rms)	50/40 kA(As applicable)
j)	Rated line charging interrupting current at 90 degree leading power factor angle (A rms)	As per IEC
	(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/√3 and 1.4 as per IEC-62271-100	
k)	First pole to clear factor	1.3
l)	Rated break time as IEC (ms)	60
m)	Total break time (ms)	65
n)	Total closing time (ms)	Not more than 200
o)	Rated operating duty cycle	O-0.3s –CO-3 min-CO
p)	Reclosing auto reclosing	Single phase / Three phase auto reclosing.
q)	Rated insulation levels	
	i) Full wave impulse withstand voltage (1.2x50micro sec.)	
	• Between lines terminals and ground:	±1050 kVp
	• Between terminals with circuit breaker open:	±1050 kVp
	ii) One minute power frequency withstand voltage.	
	• Between line terminals and ground	460kV rms.
	• Between terminals with circuit breaker open.	530kV rms.

r)	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 156kV(Micro volts)	1000
s)	Max. difference in the instants of closing/opening of contacts (ms) between poles.	As per IEC
t)	Trip coil and closing coil voltage	220V DC with variation as specified in Sec GTR
u)	Auxiliary contacts Auxiliary switch shall also comply with requirements as given. Independent single pole reversible contacts (from NO to NC & vice versa.	Each circuit breaker pole shall be provided with an auxiliary switch with 20% of spare – NO & 20% spare NC contacts for use in future.
	Rating of auxiliary contacts	10A at 220V DC
	Breaking capacity of auxiliary contacts less than 20 ms.	2A DC with the circuit time constant of not less than 20ms.
v)	System neutral earthing	Effectively earthed.
w)	Mechanical & Electrical endurance class	M2-C2

12. DISCONNECTORS (ISOLATORS)

12.1. General

Disconnectors shall be of the single-pole, group operated type, installed in the switchgear to provide electrical isolation of the circuit breakers, the transformers, shunt reactor, double bus and transmission lines. The disconnectors shall conform to IEC- 62271-102 and shall have the following ratings as specified.

Technical Parameter

Sl. No.	**Particulars**	**400kV**	**220kV**
a)	Rated voltage (rms) Un	420kV	245kV
b)	Rated frequency	50Hz	5-Hz
c)	System earthing	Effectively earthed	Effectively earthed
d)	Type	SF6 insulated	SF6 insulated
e)	Rated continuous current (A) at an ambient temperature of 40^0C	3150/4000A (for line, Transformer & reactor / bus coupler / bay)	1600/3000 A (for line / bus coupler)
f)	Rated short time withstand current of isolator and earth	50/40kA for 1 sec. (As applicable)	50/40kA for 1 sec. (As

Sl. No.	Particulars	400kV	220kV
	switch		applicable)
g)	Rated dynamic short circuit withstand current of isolator & earth switch	125/100kAp (as applicable)	125/100kAp (as applicable)
h)	Rated insulation level: One minute power frequency withstand voltage		
	To earth:	650kV rms	460kV rms
	Across isolating distance	815kV rms	530kV rms
	Rated insulation level: 1.2/50micro sec. lighting impulse withstand voltage (+ve or –ve polarity)		
	To earth:	1425kVp	1050kVp
	Across isolating distance	±1425 ±240kVp	±1200kVp
	Rated switching impulse withstand voltage (250/2500 micro. Sec.) dry & wet		
	Between line terminals & ground	±1050kVp	NA
	Between terminals with isolator open	±900kVp impulse on one terminal & 345kVp of opposite polarity on the other terminal	NA
i)	Rated mechanical terminal load	As per IEC	As per IEC
j)	No. of spare auxiliary contacts on each isolator	4 NO & 4NC	4 NO & 4NC
k)	No. of spare auxiliary contacts on each earthing switch	4 NO & 4NC	4 NO & 4NC
l)	A. Mechanical endurance class of disconnector. B. Electrical endurance class of earthing switches. i. High speed earthing switch with short circuit making capability. ii. Maintenance earthing switch	M2 (10,000) E1/E2 E0	M2 (10,000) E1/E2 E0

12.2. Construction & Design.

12.2.1. The single pole group operated disconnectors shall be operated by electric motor suitable for use on 220 v DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.

12.2.2. Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to all test duties as per Annexure –F of IEC: 62271-102. They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between busbars in accordance with Annexure-B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

12.2.3. The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

12.2.4. It shall be possible to operate the disconnecting switches manually by cranks or handwheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.

12.2.5. The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

12.2.6. The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.

12.2.7. Remote control of the disconnectors from the control room shall be made by means of remote/ local transfer switch.

12.2.8. The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

12.2.9. Each disconnector shall be supplied with auxiliary switch having four normally open and four normally closed contacts for future use over and above those required for switchgear interlocking and automation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts.

12.2.10. The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.

12.2.11. The signaling of the open position of the disconnector shall not take place

unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

12.2.12. All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.

12.2.13. The auxiliary switches shall be capable of breaking at least 2 A in a 220 V DC circuit with a time constant of not less than 20 milliseconds.

12.2.14. The disconnectors and safety grounding switches shall have a mechanical key (pad locking key) and electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.

12.2.15. The local control of the Isolator and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.

12.2.16. All electrical sequence interlocks will apply in both remote and local control modes.

12.2.17. Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under:

	SIGN	**COLOUR**
Open position	Open	Green
Closed position	Closed	Red

12.2.18. All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

12.2.19. The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.

12.2.20. The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10 mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

12.2.21. Tests: The disconnectors & earth switch shall confirm to type tests and shall be subjected to routine test in accordance with IEC – 62271-100/102

13. SAFETY GROUNDING SWITCHES

13.1. Three-pole, group operated, safety grounding switches shall be operated by electric motor for use on 220 V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.

13.2. Each safety grounding switch shall be electrically interlocked with its associated disconnector and circuit breaker such that it can only be closed if both the current breaker and disconnector are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnector.

13.3. Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Control room.

13.4. The details of the inscription and colouring for the indicator are given as under :

	SIGN	**COLOUR**
Open position	**Open**	**Green**
Closed position	**Closed**	**Red**

13.5. Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.

13.6. Each ground switch shall be fitted with auxiliary switches having four normally open and four normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.

13.7. Provision shall be made for padlocking the ground switches in either the open or closed position.

13.8. All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 100 sq. mm.

13.9. The main grounding connections on each grounding switch shall be rated to carry the full short circuit rating of the switch for 1 sec. and shall be equipped with a silver- plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

13.10. The safety grounding switches shall conform to the requirements of IEC-62271- 102

13.11. Mechanical position indication shall be provided locally at each switch and remotely at each bay module control cabinet/ substation automation system.

14. HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive currents and to withstand the associated TRV.

Single phase switches shall be provided with operating mechanism suitable for operation from a 220V DC.

The switches shall be fitted with a stored energy closing system to provide fault making capacity.

The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 125/100 kA (As applicable). The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.

Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal Control Room.

The details of the inscription and colouring for the indicator shall be as under:-

	SIGN	**COLOUR**
OPEN POSITION	Open	Green
CLOSED POSITION	Closed	Red

High speed ground switch operation should be possible locally from the bay module control cabinet, or remotely from the control room in conjunction with opening of the associated disconnector.

These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches can not be closed if the circuit breakers and disconnectors are closed.

Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

Each high speed ground switch shall be fitted with auxiliary switches having four NO & four NC auxiliary contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor

having minimum cross-sectional area of 100 sq. mm.

The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.

15. INSTRUMENT TRANSFORMERS

15.1. Instrument Transformers

15.1.1. Current Transformers

A) General :

i) The current transformers and accessories shall conform to IEC : 61869-2/1 and other relevant standards except to the extent explicitly modified in the specification.

ii) The particulars of the various cores may change within reasonable limits as per the requirements of protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores. The other characteristics of CTs shall be as given in TECHNICAL PARAMETER of Current Transformer.

B) Ratios and Characteristics

The number, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with Table-IA & 1B Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

C) Rating and Diagram Plates

Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas

section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

D) Constructional Details:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of metal- enclosed type. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

d) The rated extended primary current shall be 150% at highest ratio and 200% at ratios other than highest ratios.

e) The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably built in construction of the CTs.

f) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the marshalling box.

g) The current transformers shall be suitable for high speed auto-reclosing.

i) Provisions shall be made for primary injection testing either within CT or outside.

ii) Electromagnetic shields to be provided against high frequency transients typically 1-30 Hz.

15.1.2. VOLTAGE TRANSFORMERS

A) General

The voltage transformers shall conform to IEC- 61869-3/1 and other relevant standards except to the extent explicitly modified in the specification. Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal

box. However, for 400 kV on the lines outdoor type Capacitive Voltage Transformers suitable for carrier coupling shall be provided.

B) Ratios and Characteristics

The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Table II-A and Table II-B.

C) Rating and diagram plates

Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

D) Secondary Terminals, Earthing and Fuses

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear. All terminals shall be stamped or otherwise marked to correspond wit the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

E) The transformer shall be able to sustain full line to line voltage without saturation of transformer.

The accuracy class will be at maximum tap.

F) Constructional Details of Voltage Transformers:

a) The voltage transformers shall be located in a separate bay module on the bus and will be connected phase- to ground and shall be used for protection, metering and synchronization.

b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have three secondary windings

c) Voltage transformers secondaries shall be protected by HRC cartridge type fuses/MCB for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VT's shall be terminated to the stud type non-disconnecting terminal blocks in the

secondary boxes via the fuse/MCB.

d) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

e) The accuracy of 0.2 on secondary III should be maintained through out the entire burden range upto 100 VA on all the three windings without any adjustments during operation.

f) The diagram for the interconnection of the VTs shall be provided inside the marshalling box.

15.1.3. TESTS:

Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC.

15.1.4 TECHNICAL PARAMETERS

15.1.4.1 Current Transformers

Sl. No.	Particulars	400kV	220kV
a	Rated Voltage Un	420 kV (rms)	245 kV (rms)
b	Rated frequency	50hZ	50hZ
c	System neutral earthing	Effectively earthed	Effectively earthed
d	Rated short time thermal current	50kAp. for 1 second.	50/40 kAp. (as applicable) for 1 second.
e	Rated dynamic current	125 kAp. for 1 second	125/100 kAp. (As applicable) for 1 second
f	Rated insulation levels 1) 1.2/50 micro second impulse voltage 2) 1 minute power frequency withstand voltage 3) 250/2500micro second switching impulse voltage (Dry & wet)	 ± 1425 kVp 650 kV (ram) 1050kVp	 ± 1050 kVp 460kv (rms)
g	Maximum temperature rise over an ambient temperature of 40^0C	As per IEC 61869-2/1	As per IEC 61869-2/1
h	Radio interference voltage at 1.1Un/√3 and frequency range 0.5 to 2 MHz	1000 microvolts	1000 microvolts

i	One minute power frequency withstand voltage between secondary terminal and earth	3kV (rms)	3kV (rms)
j	Partial discharge level	10 pico coulombs	10 pico coulombs

15.1.4.2 Voltage Transformers

Sl. No.	Particulars	400kV	220kV
a	Rated System Voltage Un	420 kV (rms)	245 kV (rms)
b	Rated frequency	50hZ	50hZ
c	System neutral earthing	Effectively earthed	Effectively earthed
d	System fault level	50 kAp. for 1 second.	50/40 kAp. (as applicable) for 1 second.
e	Rated insulation levels 1) 1.2/50 micro second impulse voltage 2) 1 minute power frequency withstand voltage 3) 250/2500micro second switching impulse voltage (Dry & wet)	 ± 1425 kVp 650 kV (ram) 1050kVp for 400kV system	 ± 1050 kVp 460kv (rms)
f	One minute power frequency withstand voltage for secondary winding	3KV(rms)	3kV (rms)
g	Radio interference voltage at 1.1Un/√3 and frequency range 0.5 to 2 MHz	1000 microvolts	1000 microvolts
h	Rated total thermal burden	400VA	400VA
i	Partial discharge level	10 pico couloms	10 pico couloms

16 OUTDOOR BUSHINGS :

A) General

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR. The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear. Bushings shall generally be in accordance with the requirements of IEC publication 60137 as applicable.

B) Insulation levels and creepage distances

All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS. The creepage distance over the external surface of outdoor bushings shall not be less than 25 mm/kV.

C) Bushing types and fitting

Condenser type bushings will be preferred but alternative types can also be considered. Liquid filled bushings shall be provided with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will only be accepted if specifically approved.

D) Mechanical forces on bushing terminals

Outdoor bushings must be capable of withstanding cantilever forces due to weight of busduct and short circuit forces. Design calculations in support of the cantilever strength chosen shall be submitted for owners review and approval.

E) The major parameters of the bushings shall be as follows:-

i	Rated Voltage (kv)	420 kV	245 kV
ii	Rated current (Amp)	3150/2000 (as applicable)	1600
iii	Lightning impulse withstand voltage (kVp)	1425	1050
iv	Switching impulse withstand voltage (kVp)	1050	-
v	One minute power frequency withstand voltage kV (rms)	650	460
vi	Minimum total creepage distances (mm)	10500	6125

17 Surge Arrestors

The surge arrestors shall confirm in general to latest IEC –60099-4.

17.1 INSULATION CO-ORDINATION AND SELECTION OF SURGE ARRESTOR

The contractor shall be fully responsible for complete insulation co-ordination of switchyard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram is indicative only. If the bidders feels that at some more locations the surge arrestors are required to be provided

the same should also be included in the offer.

The contractor shall perform all necessary studies. The report shall detail the limits of all equipment parameters which could affect the insulation co-ordination .The report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents, and arrestor ratings and comply with the requirement of this specification.

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.

17.2 Duty requirements

a) The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

b) The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

c) 420 kV class Surge arresters shall be capable of discharging of severe re-energisation switching surges on a 400 kV, 450 Km long line with surge impedance of 300 ohms and capacitance of 12 nF/Km and over voltage factor of 2.3 p.u

d) 420 kV class arrester shall be capable of discharging energy equivalent to class 4 of IEC for a 420 kV system on two successive operation followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

705 kVp for 3 peaks

580 kVp for 0.1 Sec.

565 kVp for 1 Sec.

550 kVp for 10 Secs.

e) 245 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV system on two successive operations.

f) The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

g) The surge arresters are being provided to protect the followings whose

insulation levels are indicated in the table given below:-

Equipment to be protected	**Lightning impulse (kVp) for 420kV system**	**Switching serge (kVp) for 420kV system**	**Lightning impulse (kVp) for 245kV system**
Power transformer	± 1300	± 1050	± 950
Instrument transformer	± 1425	± 1050	± 1050
Reactor	± 1300	± 1050	-
CB/Isolator phase to ground	± 1425	± 1050	± 1050
Across open contacts	± 1425 (±240)	± 900 (± 345)	± 1200

17.3 Constructional Features

The nonlinear blocks shall be of infered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations. The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the manufacturer and shall be fitted with a discharge counter located in an easily accessible position. The main grounding connection from the surge arrestor to the earth shall be provided by the bidder. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

17.4 Tests

In accordance with the requirements stipulated the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document. Each metaloxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

17.5 Test on Surge Monitors :

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

17.6 Parameters

Following are the parameters for 400kV and 220 kV system generally adopted

by Owner for their installations. These parameters are indicative and not binding. The actual parameters required for the installation shall be evolved by contractor.

420KV & 220KV CLASS SURGE ARRESTOR

Sl. No.	Particulars	400kV	220kV
a)	Rated System Voltage	420 kV	245 kV
b)	System neutral earthing	Effectively earthed	Effectively earthed
c)	Rated arrester voltage	390kV	216kV
d)	Nominal discharge current	10kA of 8/20 micro second wave	10kA of 8/20 micro second wave
e)	Rated frequency	50Hz	50Hz
f)	Minimum discharge capability voltage corresponding to minimum discharge characteristics	8 KJ/kV or corresponding to Cl. 3.4.1 (d) to rated arrestor voltage and at minimum discharge characteristics whichever is higher.	5KJ/kV (referred to rated arrestor)
g)	Continuous operating voltage at 50^0C	303kV	168kV
h)	Min. switching serge residual voltage (1kA) Max. switching serge residual voltage (1kA)	730kVp 780kVp	500kVp
i)	Max. residual voltage at (i). 5kA (ii). 10kA nominal discharge current iii). 20kA nominal discharge current	 - 900kVp 975kVp	 560kVp 600kVp -
j)	Long duration discharge class	4	3
k)	High current short duration test value (4/10 micro sec. wave)	100kAp	100kAp
l)	Current for pressure relief test	40kA rms	40kA rms
m)	Prospective symmetrical fault current	40kA rms for 0.2 Sec.	40kA rms for 0.2 Sec.
n)	Pressure relief class	A	A
o)	RIV at 1.1Un/√3 kV rms (micro volts)	Less than 500	Less than 500

p)	Partial discharge at 1.05 COV	Not more than 50	Not more than 50
q)	Reference ambient temp.	50^0C	50^0C

18. 400 kV & 220 kV GIS BUILDING (If applicable):

a) The buildings shall house 400 KV and 220 KV Gas Insulated Switchgear (GIS) separately and other associated equipments inside in each of the GIS building.
b) The bidder shall submit the design & construction proposal of the building along with necessary information, data, and drawings in the techno- commercial bid according to the complete requirements.
c) The dimensions for 400 KV & 220 KV GIS building is indicated in the enclosed layout plan. The dimension given is for reference only and may vary according to requirement of the equipment to be installed inside. The bidder shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance. The dimensions indicated in the tender drawing is only indicative and minimum required. (Refer Annexure V of projects).

19. Seismic Design Criteria:

The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non concurrently. Seismic level Zone- II as per new IS- 1893, latest edition has to be considered for the design of equipment. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished along with the tender. If the equipment has not been type tested earlier, design calculations of simulated parameters should be furnished along with the offer.

To prevent the movement of GIS sub assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub assemblies to the foundation shall be designed to with-stand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the purchase's approval.

20. PARTIAL DISCHARGE MONITORING SYSTEM & DEW POINT METER

Online P.D meter, Online SF6 & O2 monitoring & alarm system and Dew point meter shall be offered as per relevant schedule of BPS and shall be considered for evaluation of bid. The specifications are enclosed at Annex-A1. Contractor shall provide adequate number of UHF sensors in the offered GIS for connection to the Online PD meter & the number & location of these sensors shall be subject to approval of the purchaser.

21. QUALITY OF SF6 GAS

a) The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 60376, 60376A & 60376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions.

b) The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations :

IS : 4379 Identification of the contents of industrial gas cylinders.

IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet Indian Boilers Regulations. (Mandatory)

c) Test

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:60376, 60376A & 60376B and test certificates shall be furnished to the owner indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for moisture, air con-tent, flash point and dielectric strength to be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

d) The bidder shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

e) The bidder shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils

and other relevant matters.

f) The bidder shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

22. SF6 GAS MONITORING DEVICES AND ALARM CIRCUITS

22.1 Dial type temperature compensated gas density or density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of the state of the gas & a separate device shall be provided for each gas compartment so that each compartment can be monitored simultaneously as follows:-

1) Compartments except circuit breaker

a) Gas Refill level

This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication.

b) 'Zone Trip' level

This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

2) Circuit Breaker

a) 'Gas Refill' level

This will be used to annunciate the need for gas refilling. The contractor shall provide contact for remote indication.

b) 'Breaker Block' level

This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate & the trip-ping & closing circuit shall be blocked.

c) 'Zone Trip' level

This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement. The bidder should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device. It shall be possible to test all gas monitoring relays/devices without de-

energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

3)

a. The gas density and pressure sensitive devices, together with all relays supplied by the manufacturer for use in protection, shall be approved by the PURCHASER. It shall be possible to test all gas monitoring relays without de-energizing the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion of the plug.

b. Two potential free electrical contacts shall be provided with each and every alarm condition. These are to be grouped together and wired to the cable termination blocks in the local control panels to give remote alarm indications/annunciation's the remote panels. The BIDDER will be advised of the grouping required after the contract has been placed. Provision shall be made for display of gas pressure of all individual gas compartment in the remote panel/HMI. The density monitor shall be provided with necessary signal Transmitter (mA) for display of actual gas pressure in the remote HMI.

c. BIDDER shall advise if the breakers are suitable for breaking the load current even if SF-6 gas pressure has reduced to atmospheric pressure.

22.2 a) Gas Leakage

The maximum gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately.

b) Gas Supply

The contractor shall include the supply of all SF6 gas necessary for filing & putting into operation the complete switchgear installation being supplied. In addition 20% of total gas requirement shall be supplied in separate cylinders as spare requirement, over & above the requirement of gas for successful commissioning. Pl. refer list of mandatory spares in this connection.

23. GAS FILLING AND EVACUATING PLANT

All the plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied with the contract to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed when carrying out maintenance or repair work on the switchgear and associate equipment of at least one complete bay. Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes. The capacity of evacuation plant will be as under :

Vacuum Pump: 40 M^3/Hour(Nominal suction pressure)

Compressor: 15 M^3/Hour(Delivery)

The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases. The gas compartments shall preferably be fitted with permanent non-return valves through which the gas is pumped into or evacuated form the compartments. Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be provided along with the bid.

24. SF6 GIS to XLPE Cable Termination (If Applicable):

The 220 kV underground cables are to be connected to 220 kV GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure for making connection 1C x 1000 sq mm (As applicable) XLPE cable. Cable termination kit shall be supplied by cable supplier. The ducts and the casing shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

The SF6 GIS to XLPE cable termination shall conform to IEC-62271-209(latest edition).

The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The bidder may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be supplied by the supplier. The supplier

may specify alternative connecting & supporting arrangements for approval of the purchaser.

The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The typical arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall be submitted along with offer.

25. Electric Overhead Crane (If applicable):

One EOT Crane each for 400kV & 220kV GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipments.

26. The crane shall be possible to be operated through the cable & through the pendant control or through remote control device, which shall be easily accessible from the floor of GIS building.

The crane for 400kV GIS hall shall have capacity of minimum 6T safe working load & minimum height of crane shall be 9.0 meters or as per actual requirement whichever is higher.

The crane for 220kV GIS hall shall have capacity of minimum 5T sage working load & minimum height of crane shall be 8.0 meters or as per actual requirement whichever is higher.

EOT Crane shall be provided with Double Girder type.

27. TRANSFORMER / REACTOR TERMINATION MODULE (If applicable):-

The transformer/reactor termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer/reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's/reactor's foundations are absorbed by the expansion fittings.

OR

The oil filled transformers and reactors are as shown in the sub-station SLD. The oil to air bushings of the 400/220/33kV autotransformers and 400kV reactors shall be supplied by the respective supplier's and the same shall be connected to the SF6 ducts through air to SF6 bushings to be provided under present scope.

28. PAINTING OF ENCLOSURE

All enclosures shall be painted externally as per manufacturer's painting procedure. The painting procedures as followed shall be enclosed with the bid.

29. HEATERS

Wherever required, heaters shall be provided to prevent moisture condensation. Heaters are not allowed in side the main circuit.

30. IDENTIFICATION & RATING PLATE

i) Each bay shall have a nameplate showing

   a) A listing of the basic equipment from air entrance bushing to air entrance bushing such as a breaker, disconnectors grounding switches, current transformers, voltage transformers, and bushings).

   b) A schematic diagram indicating their relative locations.

   c) KPTCL Contract Number.

ii) Each module will have its own Identification & rating plate.

The rating plate marking for each individual equipments like circuit breaker, disconnectors grounding switches, current transformer, voltage transformers, surge arrester etc shall be as per their relevant IEC.

31. TRANSPORTATION OF EQUIPMENT TO SITE

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities .All transport packages containing critical units viz Circuit breakers, disconnectors, earth switches, surge arrestors and bus sections exceeding 3 metres length shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, within three weeks the contractor shall communicate the interpretation of the data.

32. PACKING, STORAGE AND UNPACKING

All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

The SF6 metalclad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metalclad equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment. The type of gas, the maximum pressure to which sections will be filled prior to shipment and the minimum allowable pressure during shipment shall be advised prior to dispatch.

All banking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided as part of the contract and shall remain the property of KPTCL. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O' rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification serial numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.

Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected.

The contractor will be able to use the available storage areas at site.

The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungoral growth. The scope of providing the necessary protection, storing off the ground, as required etc. is included in the works to be performed by the contractor.

The equipment shall only be unpacked or removed from the containers immediately prior to being installed. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen/air or SF6 gas until required.

TABLE-IA-I
Requirements for 420kV Current Transformer
(For Line and Bus coupler feeder)

No. of cores	Core no.	Application	Current ratio	Output Burden(VA)	Accuracy class	Min. knee point voltage Vk	Max. CT sec. wdg. Resistance(ohm)	Max. excitation current at Vk(in mA)	Remarks
5	1	BUS DIFF	3000-2000-1000/1	-	PS	3000/2000/1000	15/10/5	20 on 3000/1 tap 30 on 2000/1 tap 60 on 1000/1 tap	
	2	BUS DIFF	3000-	-	PS	2000/	15/10/5	20 on	

			2000-1000/1			2000/1000		3000/1 tap 30 on 2000/1 tap 60 on 1000/1 tap	
	3	METERING	3000-2000-1000/1	20 20 20	0.2S 0.2S 0.2S	-	-	-	
	4	BACKUP/ LINE PRTN	3000-2000-1000/1	-	PS	3000 2000 1000	15/10/5	20 on 3000/1 tap 30 on 2000/1 tap 60 on 1000/1 tap	
	5	LINE PRTN	3000-2000-1000/1	-	PS	3000 2000 1000	15/10/5	20 on 3000/1 tap 30 on 2000/1 tap 60 on 1000/1 tap	

All relaying CTs shall be of accuracy class PS as per IS: 2705/IEC-61869-2/1

TABLE-IA-II
Requirements for 420kV Current Transformer
(For Transformer and Reactor feeder)

No. of cores	**Core no.**	**Application**	**Current ratio**	**Output Burden(VA)**	**Accuracy class**	**Min. knee point voltage Vk**	**Max. CT sec. wdg. Resistance(ohm)**	**Max. excitation current at Vk(in mA)**	**Remarks**
5	1	BUS DIFF	2000-1000/1	-	-	2000/1000	10/5	30 on 2000/1 tap 60 on 1000/1 tap	
	2	BUS DIFF	2000-1000/1	-	-	2000/1000	10/5	30 on 2000/1 tap 60 on 1000/1	

								tap	
	3	METERING	2000-1000-500/-	20 20 20	0.2S 0.2S 0.2S	-	-	-	
	4	TRANS/Reactor BACKUP	2000-1000-500/1	-	-	2000 1000 500	10/5/2.5	30 on 2000/1 tap 60 on 1000/1 tap 120 on 500/1 tap	
	5	TRANS/Reactor DIFF	2000-1000-500/1	-	-	2000 1000 500	10/5/2.5	30 on 2000/1 tap 60 on 1000/1 tap 120 on 500/1 tap	

All relaying CTs shall be of accuracy class PS as per IS: 2705/IEC 61869-2/1

TABLE-IB
Requirements for 245kV Current Transformer

No. of cores	**Core no.**	**Application**	**Current ratio**	**Output Burden(VA)**	**Accuracy class**	**Min. knee point voltage Vk**	**Max. CT sec. wdg. Resistance(ohm)**	**Max. excitation current at Vk(in mA)**	**Remarks**
5	1	BUS DIFF CHECK	1600-800/1	-	-	1600/800	8/4	25 on 1600/1 tap 50 on 800/1 tap	
	2	BUS DIFF. MAIN	1600-800/1	-	-	1600/800	8/4	25 on 1600/1 tap 50 on 800/1 tap	
	3	METERING	1600-800/1	20	0.2S	-	-	-	

	4	TRANS BACKUP/LINE PRTN	1600-800/1	-	-	1600/800	8/4	25 on 1600/1 tap 50 on 800/1 tap	
	5	TRANS DIFF /LINE PRTN	1600-800/1	-	-	1600/800	8/4	25 on 1600/1 tap 50 on 800/1 tap	

All relaying CTs shall be of accuracy class PS as per IS: 2705/IEC 61869-2/1

TABLE-IIA
Requirements of Voltage Transformer

Sl. No.	**Particulars**	**400kV**			**220kV**		
1	Rated primary voltage	420/√3 kV			245/√3 kV		
2	Type	Electro magnetic, or single phase capacitor VT			Electro magnetic		
3	No. of secondaries	3			3		
4	Rated voltage factor	1.2 continuous 1.5 – 30 seconds			1.2 continuous 1.5 – 30 seconds		
5	Phase angle error	± 20 minutes			± 20 minutes		
		Sec I	**Sec II**	**Sec III**	**Sec I**	**Sec II**	**Sec III**
6	Rated voltage (V)	110/√3	110/√3	110/√3	110/√3	110/√3	110/√3
7	Application	Protection	Protection	Metering	Protection	Protection	Metering
8	Accuracy	3P	3P	0.2	3P	3P	0.2
9	Output burden (VA) (Minimum)	50	50	50	50	50	50

Annexure-A1

TESTING & MAINTENACE EQUIPMENT

Testing & Maintenance equipment shall be offered, as per relevant schedule of BPS.

1. SF6 Gas leakage detector.

The detector shall be portable, battery operated, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The sensor shall be connected through a flexible wand for easy accessibility to joints, seals and couplings in GIS equipment and provided with a protection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard. The test kit shall be compatible for EMI/EMC environment as per IEC 1000.

2. Gas filling and evacuating plant: (Gas Processing unit)

a. The plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete bay (switchgear and associated equipment).

b. Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.

c. The minimum capacity parameters of evacuation plant will be as under:

Oil Free Suction (Recovery) Pump: 30 M3/Hour

Compressor (Two Stages): 15 M3/Hour

Oil Free Vacuum Pump: 100 M3/Hour

d. The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases. Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished.

Online Partial Discharge Monitoring System (Applicable for 400kV GIS substation –Both on 400kV side & 220kV side)

GIS equipment shall be designed so as to minimize partial discharge or other electrical discharge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.

An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.

On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection.

The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble free online PD monitoring of complete GIS installation shall be considered as included in the scope.

The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHF PD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval.

The integration of UHF PD coupler in future GIS bays shall be done in respective package. The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision).

The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, printer. The workstation PC shall be powered by suitable dedicated UPS and same is included in the present scope.

Design of on-line PDM System

1. The technical proposal for PDM system along with detailed design documentation shall be submitted for EMPLOYER’S approval during

engineering stage.

2. To guarantee that sufficient coverage is available for complete GIS installation to monitor PD activity all design details shall be submitted as part of the above for review.

3. The sensitivity of the offered system shall be in accordance with CIGRE Document No. 654 that will be verified as part of site sensitivity tests.

4. UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.

5. The signal attenuation level of co-axial cable per meter length and justification for the length of cable connection between the couplers and detector units shall be furnished.

6. The overall sensitivity of PD detection system shall take into account the spacing between couplers and the associated cabling, filters, amplifiers, etc.

7. The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc. shall be submitted during engineering stage for approval.

8. The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labeling and indicated in the substation PDM SLD.

9. Internal arrangement/wiring diagram is to be submitted for detector units/control cabinet etc. All internal items are to be identified / labeled to facilitate troubleshooting.

10. Supply requirement (AC & DC) to be specified for the complete monitoring system.

11. Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration. Ratings of UPS shall be proposed for the approval of EMPLOYER'S. The UPS shall have enough capacity to initiate a 'safe' shut down of the PDM PC and the peripherals after this 15-minute period if normal supply fails to resume. The PDM PCs shall restart automatically on resumption of normal supply. The UPS shall not generate spikes during changeover of supply. UPS shall automatically give indication / alarm when it requires battery replacement.

Potential Free Contacts shall be generated to signal these events. These

contacts shall be wired out to Annunciation / Monitoring systems. Alternately, inverter of suitable capacity is also acceptable. Critical Process and Status alarms of the PDM system shall be displayed.

12. PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc.

13. Method of electrical isolation/protection provided between PD sensor and detector circuitry in case of flashover/high potential stress inside GIS should be furnished.

14. The selected mode of propagation of PD signal (electromagnetic wave) inside GIS for the design of sensors shall be furnished.

15. The protection available for electronics against transient over voltages caused by switching operations shall be furnished.

16. The capacity of each detector unit to be specified to accommodate as many numbers of PD sensors signal.

17. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation has to be submitted in this regard.

18. Guaranteed technical particulars & data sheet for various components used in the system shall be submitted.

Calibration: The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

Every Day Use & Maintenance: The system shall be designed suitable for an unmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure,

thereby eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.

Computers and Peripherals: The PC operating system shall be the latest version of MS Windows. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available in the market of industrial type subject to EMPLOYER'S / Engineer approval. For storing the historical PD database, sufficient storage facility in the form of hard disc and retrievable hard disk drive of 1TB as specified shall be available in the substation. The PC monitor shall be 21" LCD type of reputed make.

Filtering Facility: The filtering facility has to be provided in order to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noise

from real PD. The exposed gas barriers of the GIS shall be shielded effectively against noise interference & tested. The gas barrier shields/belts shall be suitable for outdoor use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as an option) to filter out noise signals in the trend plot display. If hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. The method adopted for the above shall be specified taking into account the sensitivity requirement of PDM system as per CIGRE document. The noise filters shall be selectable individually coupler-wise.

Self-Test (Diagnostic) Facility: Built-in self-checking facility shall be incorporated in the control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger an alarm for communication to SAS. External check facility: Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.

Detector Units: The sensitivity of each detector unit shall be furnished. The sensitivity level of individual detector units shall be selectable depending on the site background noise level.

Trend Plot: The trend plot facility shall be available with the update period of hourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.

PD Monitoring modes: There shall be two different modes of system operation viz. a dedicated Continuous PD Monitoring mode for the normal day today operation of the system & a dedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature.

In the HV Commissioning mode the real time display shall be possible for a minimum of two complete bays with associated bus bars and at with one second update period. The HV test software shall automatically record the HV voltage information along with PD so as to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.

Alarm Facility: The PDM system shall generate alarm when action is required; viz. a) PD alarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to be connected to SAS.

Real Time Display: The PDM system should have the facility of Real Time display, which will give an instant indication of PD activity coupler wise, with one-second-update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators.

Schematics: The PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.

Print Option/Facility: PDM system should have the option/facility of printing all trend plots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for this purpose at substation.

Data Archives: This is to provide access to historical data and file storage with date and time stamp. Sufficient storage facility shall be available to review historical data updated for the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.

PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance

Diagnostic Software: In order to interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built- in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist.

The bidder shall also make available typical point-on-wave patters as library pictures to train the user.

Software Updates: It shall be possible to upgrade / update the system software throughout the lifetime of the system with the ongoing development / refinement in PD technology.

Fault investigation: In case of any indication of suspected PD activity by the on line system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty period.

Special Tools / equipment, Spare Parts, software packages

Special Tools: Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.

Spare parts: The contractor has to supply critical spares with replacement procedure for the trouble free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included in the tender and also submitted for EMPLOYER'S approval during the detailed engineering stage.

Software Packages: The complete software package shall be supplied as part of a back-up facility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. The list shall be submitted for reference.

Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

Operation & Maintenance Manual: A complete O&M manual covering all aspects of trouble shooting of PDM system in six sets in original shall be provided & also in CD's. For diagram references colour pictures shall be provided. A step-by-step procedure for spare parts replacement shall also be included.

Factory / Site Test Formats: The factory & site tests format to be submitted for approval. The format shall cover all possible tests to confirm healthiness of the system and to record the test values.

List of References: The bidder shall provide a reference list of PD monitoring system.

TECHNICAL SPECIFICATIONS FOR ONLINE SF6 and O2 MONITORING & ALARM SYSTEM

1.0 General

The online SF6 & O2 gas monitoring and alarm system shall be used for detecting hazardous SF6 gas built-up in enclosed areas such as GIS switchgear rooms, cable trenches and other rooms used to store SF6.

The gas build up in enclosed spaces can be as a result of slow gas leakage from switchgear caused by damage or corrosion of switchgear seals or pressure housings, in service, or during maintenance, leakage of gas filling valves or due to emergency venting of gas due to internal pressure rise in the equipment during a fault.

It shall be suitable for indoor EHV switchgear rooms.

Pure SF6 gas is colourless, odourless, non-flammable, inert gas. At room temperature the density is more than five times that of air.

In switchgear, SF6 acts as both insulation and an arcing media. During arcing and partial discharge events, under the influence of high temperature and other factors, SF6 gas will be decomposed. Decomposition can produce highly toxic products, such as SF4, S2F2, SOF2, HF, SO2, etc. if these are inhaled, they can cause pulmonary oedema and dizziness, coma and even death.

In the relatively closed interior of a switch room, due to poor air circulation, SF6 decomposition and deposition in the room can reach harmful level during emergency conditions.

When leaking SF6 gas accumulates at lower levels in a switch room or adjoining cable trenches (due to its density) caused by a major accident, it can displaced enough O2 to result in local hypoxia, asphyxiation.

The principle of operation shall be based on infrared laser absorption spectroscopy detector principle.

The system components are as follows:

(1). Host computer: Real time display of various parameter and integrated analyzer for calculation of all monitored parameters and alarms thresholds.

SCADA alarm and data transmission and control of forced ventilation fans, local alarms, lights etc.

(2). SF6 gas laser detector: Four Gas Laser Detector Unit containing the laser absorption spectroscopy module that analyses the sampled gas for analysis from up to four (4) Collector Units. The obtained data is uploaded to the host through an RS

485 connection.

(3). Collector: Collector for sampling and associated gas particle filtration pre-treatment. These are to be installed at the LOWEST place in the monitored area. (SF6 gas sinks to low spot).

(4). Infrared proximity switch: Entry of persons into the GIS area automatically starts the fan and voice prompts.

(5). The Box (Cabinet) is located in the control or relay room to control the fan start and stop and provide power to each device.

(6). Sound and light alarm devices: If SF6 or O2 set value is exceeded, an alarm sounds to alert staff.

System Installation:

Site survey

1. If possible, a site survey must be carried out and any special considerations identified and marked up on user-supplied drawings. Based on this, it should be possible to select the installation locations for sensors and the other parts.

2. The collector must be placed in sets of four (4) units so that they can connect to their allocated Four Gas Laser Detector Unit.

3. The Host Controller should be placed in an area where there is access to input power, output telecommunication lines, fan control and alarm lines.

System features:

1. Real-time display functions of various parameters.

2. Environmental SF6 gas content detection.

3. Environmental O2 content detection.

4. Environmental temperature and humidity detection.

5. Alarm when SF6 gas content exceeded allowable threshold.

6. Hypoxia alarm (i.e. Low O2 level).

7. Temperature exceeded alarm and start conditioning function.

8. Excessive humidity alarm and control of the dehumidifier function.

9. Excessive levels of hypoxial or SF6.

10.Control of exhaust air ventilation function.

11. Log query capabilities.

12. Voice prompts.

13. Sound and light alarm.

14. Last exhaust display.

15. Intelligent screen saver function.

16. Remote data transmission capabilities.

Technical Parameters:

- SF6 gas concentration alarm: 0~2000 X 10-6(v/v)
- SF6 gas detection sensitivity: ± 2% (laser type)
- ± 5% set value (electrochemical transmitters)
- Detect oxygen concentration: 0~25U% (with digital display)
- Oxygen concentration alarm threshold: Adjustable
- Oxygen measurement accuracy: <0.5%(0.4%, O2 when 21%)
- Temperature display range : -25~99° C
- Temperature measurement accuracy : <0.5%
- Temparature alarm thresholds: Adustable
- Humidity display range : 0~99% RH
- Humidity measurement accuracy: <3%
- Input Voltage 176 ~ 265V AC
- Alarm output points: 5A
- Fan output points: 5A
- Fan output contacts Power : 380V AC 40A
- Fan ventilation time setting : 15Min / second (adjustable)
- Data recording time : 2 years, the PC mass storage
- Communication: RS-485 standard protocol

Environmental operational requirements:

- Temperature: Operating temperature – 25° C -+85° C
- Humidity: less than 95% RH

TECHNICAL SPECIFICATIONS FOR SUPPLY, LAYING, TESTING & COMMISSIONING OF 2500 Sq.mm., 220KV XLPE INSULATED UNDERGROUND CABLE AND ACCESSORIES

AND

TECHNICAL SPECIFICATIONS FOR SUPPLY, LAYING, TESTING & COMMISSIONING OF 2000 Sq.mm., 220KV XLPE INSULATED UNDERGROUND CABLE AND ACCESSORIES

TECHNICAL SPECIFICATIONS FOR SUPPLY, LAYING, TESTING & COMMISSIONING OF 2500 Sq.mm., 220KV XLPE INSULATED UNDERGROUND CABLE AND ACCESSORIES

1.00.0 SCOPE:

1.01.0 This specification provides for the establishment of an underground cable transmission scheme on total turnkey basis which includes the design, manufacture, inspection and testing before despatch, packing and delivery F.O.R. (destination) of 220KV, 2500 Sq.mm, Single Core XLPE Insulated lead sheathed cable and accessories under the supply portion and laying, including obtaining permission for road cutting from Bruhath Bengaluru Mahanagara Palike (BBMP), Local Administrative Authorities and other agencies for execution of work, handling and installation of materials required in laying, site testing and commissioning under the erection portion.

1.01.1 SITE:

The site is located in Karnataka State, India.

Route: Please refer the enclosed drawing for the tentative route plan of the cable.

1.02.0 SCOPE OF WORKS

The scope of work includes:

1.02.1 Surveying of the proposed cable route including digging and closing of trial pits, preparation of requisite drawings and finalizing the cable route in consultation with the owner's representative.

NOTE: In the expected cable route, ground structure may change from one point to another, and in some places like Railway Crossing , Major Road Crossing, the local environment is especially bad which may lead to unexpected accelerated ageing of insulation and would limit the life expectancy of the cable itself. The successful bidder has to execute works by taking all the necessary precautions so as to get 95**0 Amps** of current flow in the cable per circuit (Refer clause No. 4.00 (B)(i)(10)(i) & (ii)).

Even after considering all the derating factors for laying cable in those locations, the minimum continuous current shall be 1350 **Amps** per circuit.

1.02.2 Testing and evaluation of the soil resistivity, soil thermal resistivity, pH value, of the soil along the cable route, and based on the data, recommend the final system design.

a) Perform a through route soil thermal resistivity survey by in-situ testing

along the entire cable route.

b) Conduct a detailed analysis of soils / strata encountered along the route for the thermal performance under specified cable loading.

c) Specify a suitable thermal backfill so that the soil thermal resistivity does not exceed 120^0C cm/watt, to encapsulate the cables to prevent thermal run away of cable.

d) Design of optimum cable trench including RCC ducts and optimum backfill dimension.

e) Formulation of thermal backfill, quality control and supervision during backfill.

f) Obtaining Road cutting permission from Bruhath Bangalore MahanagaraPalike (BBMP), Local Administrative Authorities and any other permissions from other utilities.

1.02.3 Design the method of installation of U.G. Cables, cable laying, excavation and back-filling of cable trench, supply and installation of associated materials like sand, bricks, warning tape, protective slabs, pipes, ducts, civil works etc.

1.02.4 Design, manufacture, testing at works / test house, supply, storage, installation, testing and commissioning of 220 kV cables with all associated materials and accessories.

1.02.5 Design, supply erection, testing and commissioning of

a) Surge Voltage limiters

b) Grounding Switches.

c) Link boxes with Links and with/without SVL

1.02.6 Design for the installation, supply of materials and construction of cable ducts, supports for cable crossings of storm water/sewerage drains wherever required. Design, supply of materials and laying of pipes/construction of cable ducts for railway crossing and road crossing wherever required.

1.02.7 Supply, installation, testing and commissioning of

a) Normal straight through joints for Normal bonding/ Cross bonding of cables.

b) Outdoor cable terminations.

1.02.8 Design, supply and erection of structures for mounting / supporting cable with terminations.

1.02.9 Supply of recommended essential spare parts.

1.02.10 Supply of tools and tackles.

1.02.11 Furnishing all relevant drawings, data and instruction manuals.

1.02.12 Supply of all consumable items, like cable end sealing caps for cable during transport and jointing and all others associated sundry materials.

1.03.0 SCOPE OF SERVICES:

1.03.1 The Scope of the services includes supply, installation, laying erection and commissioning of the cable system on total turnkey basis. The scope shall include but not limited to the following.

1.03.2 Complete checking, monitoring, storing of the materials at the site, and co-ordination of work. Transporting of materials from site stores to site and returning unused material to KPTCL stores.

1.03.3 Finalize procedure of installation and erection in consultation with owner.

1.03.4 Regular supervision and following up of erection / installation work

1.03.5 Testing and commissioning the system / equipments for successful commercial operation.

1.04.0 The cables and its accessories shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer / erection and the owner shall have the power to reject any work or material, which in owner's judgement is not in full accordance therewith.

1.05.0 All the volumes of this bid documents along with amendments thereof be read and interpreted together. However, in case of a contradiction between the "Technical Specification (Vol. II)" (i.e., this volume) and any other volume, the provisions of this volume will prevail.

1.06.0 It is not intent to specify completely all the details of Design and construction of cable and accessories. However, the cable and accessories shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing continuous commercial operation up to the suppliers guarantee period in a manner acceptable to the Owner who will interpret the meanings of drawings and specifications and shall have power to reject any work or material, which in Owner judgment, is not in accordance

therewith. The cable offered shall be complete with all the components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of the bidder irrespective of whether they are specifically brought out in this specification and/or in the commercial document or not.

NOTE:

1. The scope shall cover supply of all required equipments, accessories, spares and jointing kits and tools and plant, competent supervision and consumables. All other matching materials required (whether specifically mentioned or not) for complete installation, testing and commissioning of the system shall also be covered.

2. After completion of laying and back filling the road shall be restored as per specification of BBMP and applicable local Authorities. Specification of the same is enclosed.

1.07.0 QUANTITIES:

The quantities, length of cable, number of accessories and other materials indicated in the bid proposals are solely for the purpose of bid evaluation. The successful bidder after detailed route survey shall estimate the actual quantities and take up manufacture and procurement action for materials after approval of the Owner.

2.00.0 STANDARDS:

2.01.0 The construction of the cable shall generally conform to IS 7098 (Part-3) and IEC 62067 with exception to the specific requirements of these specifications and tests as per **IEC-62067**. Except to the extent mentioned in the specification, the cables and the accessories shall conform to the latest editions and amendments of the standards listed hereunder wherever applicable.

IEC-60050	Electro Technical vocabulary.
IEC-60060	High Voltage Test Techniques.
IEC-60093	Recommended tests for volume and resistivity of electrical insulating materials.
IEEE-48	Test procedures and requirement for AC cable terminations 2.5 to 765kV
IEC-60122	Recommended method for determining the comparative tracking index of solid insulating materials under moist condition.
IEC-60183	Guide to selection of high voltage cables.
IEC-60216	Guide for the determination of thermal endurance properties of electrical insulating materials.
IEC-60228	Conductors of insulated cables.
IEC-60228-A	(First supplement) Guide to the dimensional limits of circular conductors.
IEC-60229	Test on cable over sheaths which have a special protective function and are applied by extrusion.
IEC-60230	Impulse test on cables and their accessories.
IEC-60243	Recommended method of tests for electrical strength of solid insulating materials.
IEC-60250	Recommended method for determination of permittivity, dielectric dissipation factor of electrical insulation materials at power, audio frequencies.
IEC-60270	Partial Discharge measurements
IEC-60287	Calculation of continuous current rating of cables, 100% load factor.

IEC-60540	Test methods for insulation and sheaths of electric cables and cores.
IEC-60811	Common test methods for insulating and sheathing materials of electric cables. (Applicable parts / sections of different editions)
IEC-60840	***Applicable clauses only*** Power cable with extruded insulation for voltages above 30kV (U_m=36kV) up to 150 (U_m=170Kv). Test methods & requirements.
IEC-60853	Calculation of cyclic & emergency current rating of the cable.
IEC-60885-2	Electrical test methods for electric cables, part-2: Partial discharge tests.
IEC-60885-3	Electrical test methods for electric cables part-3 Test methods for partial discharge measurement on lengths of extruded power cables.
IEC-62067	Power cable with extruded insulation and their accessories for rated voltage above 150 kV – Test Methods & requirements.
IEC-60949	Calculation of thermally permissible short circuit currents, taking into account non-adiabatic heating effects.
IS-3043	Code of practice for earthing
IS-1255	Code of practice for laying of power cables.
IS-1885	Electro Technical vocabulary applicable parts.
IS-5216	Guide for safety procedures and practices in electrical works
IS-5831	PVC insulation and sheath of electric cables.
IS 7098 (Part 3)-93	Cross-linked polyethylene insulated, thermoplastic sheathed cables 66kV to 220kV.
IS-8130	Conductors for insulated cables and flexible cords.

IS-10810	Method of test for cables: Applicable parts.
IEC-62271-209	Cable Connection for gas insulated metal enclosed switch gear for rated voltage above 52kV.
Indian Electricity Act - 2003	Indian Electricity Rules, 1956 (Or its Latest Amendments)

NOTE: i) For the purpose of this specification all technical terms used hereinafter shall have the meaning as per relevant IEC/IS specification.

2.02.0 The Standards mentioned above are available from:

Standard	Name & Address
IS	Bureau of Indian Standards, ManakBhavan, 9, BahadurshahZafarMarg, New Delhi – 110 001, INDIA.
IEC	International Electro-Technical Commission, Bureau Central De 1a commission, Electro Technique Internationale, 3, Rue De Verembe,P.O. Box 131 CH- 1211 Geneva 20 – Switzerland.

2.03.0 Cables/Cable accessories satisfying the quality requirements of other National/International standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the bidder conforms to other standards, salient points of difference between the standards preferred and the specified standards shall be clearly brought out in the offer. Four (4) copies of the reference standards in English language shall be furnished along with the offer.

3.00.0 SYSTEM DATA:

a) Rated voltage:

The cable defined in this specification have the following rated voltage:

$$U_o/U\ (U_m) = 127/220\ (245)\ kV$$

"U_o" is the r.m.s. rated voltage at power frequency, between the conductor and the earth or the metallic sheath:

U_o = 127 kV

U is the r.m.s. rated voltage at power frequency, between two phase conductors:

U = 220 kV

"U_m" is the maximum r.m.s. voltage at power frequency, between two conductors for which the cable and its accessories are to be designed:

U_m = 245 kV

b) Operating Conditions:

1.	Nominal rated voltage (KV rms)	–	220 KV
2.	Highest system voltage (kV rms)	–	245 KV
3.	Number of phases	–	3
4.	System frequency (Hz)	–	50 ± 3%
5	Impulse withstand voltage 1.2/50 micro seconds wave of positive/negative polarity (kVp)	–	1050
6.	Power frequency withstand voltage (kV rms)	–	460
7.	System earthing	–	Effectively Earthed (Solidly grounded)
8.	Maximum fault level & its duration	–	50KA for 1 Sec
9.	Dynamic withstand capability	–	125 KA
10.	Total Relay & Breaker operating time (Milli seconds)	–	90-120

4.00.0 A. CLIMATIC CONDITIONS:

1.	Ambient air temperature	–	Min 5^0C
		–	Max 50^0C
2.	Average daily ambient air temperature	–	30^0C
3.	Relative humidity	–	10–100%
4.	Ground temperature at a depth of 1500 mm	–	30^0C
5.	Altitude above Mean Sea Level (M)	–	1000

6.	Average Rainfall (mm)/annum	–	1000
7.	Ceraunic level (days/year)	–	40–50
8.	Seismic level (horizontal acceleration)	–	0.3 g

B. OPERATING CONDITIONS:

i. CABLES:

1.	Method of installation	–	Directly buried in ground/RCC cable duct
2.	No. of Circuit	–	Single
3.	Depth of laying (average)	–	1500 mm from the center of cable arrangement
4.	Soil Condition	–	Dry Heterogeneous Garden Soil
5.	Thermal Resistivity of soil (assumed) Deg. C-cm/watt	–	120 to 150

Bidder shall furnish the current rating of 2500 Sq.mm cable at Thermal resistivity of soil at 120^0C-Cm/watt and 150^0C-Cm/watt. However the successful bidder has to measure the soil thermal resistivity along the cable route and the cable has to be designed suitably.

6.	Formation	–	Horizontal
7.	Spacing between two circuits (if applicable)	–	800 mm (for 2 Circuits)
8.	Sheath Bonding	–	Cross bonding.

Bidder shall recommend the type of bonding to be adopted with detailed calculation of sheath voltage, sheath current and current rating.

9.	No. of cores		–	Single
10.	Conductor size		–	2500 Sq.mm
11.	Rated continuous current (minimum)			
	i.	In Air	–	1500 Amps.
	ii	In ground	–	1350 Amps. (after considering all derating factors)
12.	Conductor material		–	Annealed Copper

ii. TERMINATIONS:

1)	Installation	–	Outdoor type/GIS module Plugin Type in conformity with IEC 62271-209.
2)	Atmosphere	–	Polluted.
3)	Switchgear	–	SF6 Circuit breaker (AIS/GIS)
4)	Clearance (air) ph-ph	–	3650 mm
	at 220kV (phase voltage) ph-earth	–	3350 mm

5.00.0 TECHNICAL PARAMETERS OF CABLE:

TYPE OF CABLE:

127/220 kV single core, stranded, annealed, copper conductor, segmental compacted, circular (Miliken), XLPE insulated, lead sheath, copper wire screen, High Density Polyethylene outer sheathed cable (please see details under construction of cable).

The tests shall be as per IEC-62067 with latest amendments.

Voltage grade	–	127/220 (kV rms)
Max. operating conductor temperature	–	90^0C
Max. conductor temperature under short Circuit for 1 sec.	–	250^0C

5.01.0 CONSTRUCTION OF THE CABLE:

Construction : 127/220 kV (Earthed), single core 2500 Sq.mm stranded, annealed, copper conductor, segmental, compacted, circular (Milliken), conductor screen, cross linked polyethyline (XLPE) insulation, core screen, semi-conducting water swellable layer, lead alloy 'E' sheathed, semi-conducting bedding tapes, helically applied plain round copper wire screen, plain copper tape in open helix, water

swellable tape with overall extruded High Density Polythylene sheath coated with graphite.

Conductor : Plain, annealed, high conductivity copper wires stranded, segmental conductor (Milliken).

Conductor screen : Extruded semi-conducting layer.

Insulation : Dry cured cross linked polyethyline.
Nominal thickness 25
.00 mm (min)
In any particular point, the thickness may differ from the nominal thickness, however, the measured thickness shall stay within the following limits.
Minimum thickness: $t_{(min)} \geq 0.9\ t_{(nom)}$
And

$$\frac{t_{max} - t_{min}}{t_{max}} \leq 0.10$$

Where t_{max}, t_{min} and t_{nom} are respectively the minimum, maximum & nominal thickness.

The thickness of insulation mentioned is indicative only. However, the thickness of insulation shall be such that the maximum value of electric stress at the insulation screen shall be 4kV/mm, as indicated elsewhere in the specification.

Core/insulation Screen Extruded semi-conducting layer

Longitudinal Water barrier Semi-conducting water swellable tape/s.

Radial Moisture Barrier Extruded lead alloy ‘E’.
(Nominal thickness not less than 3.0 mm)

	The minimum thickness of the metallic sheath shall not fall below the nominal thickness by more than 0.1 mm + 5.0% of the nominal thickness. $t_{min} \geq 0.95 t_{nom} - 0.1$
Bedding	Semi-conducting tape/s.
Armour/Screen	Helically applied non-magnetic plain copper wires.
Contact tape	Annealed plain copper tape in open helix.
Water swellable tape	Non-conducting water swellable tape.
Outer sheath	Extruded High Density Polyethylene type ST 7 (black), antitermite treated. Extruded outer conducting layer coated with graphite. Nominal thickness 3.5 mm

6.00.0 GENERAL TECHNICAL REQUIREMENTS OF THE CABLE:

The size of the conductors of the cable shall be sufficient to carry continuously 950 **Amps** continuously without exceeding a maximum temperature of **90^0C** under site conditions followed by a 20% overload for three hours without exceeding a maximum temperature of 130^0**C for emergency overload** under site conditions. The OWNER estimates that a cross section of 2500 sq.mm Compacted Segmental Circular Milliken conductor would be adequate to carry the stipulated load current.

The conductor size shall be based on loading of the circuit under the conditions indicated in Clause-3.00.00 & 4.00.00 above.

6.01.0 INSULATION CURING:

Dry curing process should be adopted in cross-linking the insulation.

6.02.0 TRIPLE EXTRUSION:

The conductor, screen, insulation and insulation screen shall be extruded in single process. The extrusion process shall be by **VCV method**. The same shall be confirmed in the GTP.

The Cross linked polyethylene insulated (XLPE) cable (Dry cured) shall be manufactured in accordance with the internationally accepted standard and also conform to the requirements of IEC: 62067 for rated voltages from 150KV to 500KV.

6.03.0 DESIGN STRESS AND INSULATION THICKNESS:

The recommended typical design stress values for insulation thickness are:

Design stress a.c.	:	**10 kV/mm**
Design stress impulse	:	**40 kV/mm**

The higher of the two values of the insulation thickness will be adopted but not less than the nominal value of 24.00 mm.

6.04.0 DIELECTRIC STRESSES:

The 220 kV cables shall be designed for continuous operation at a maximum line to earth system voltage of 127 kV. The maximum dielectric stress at the conductor screen and insulation screen shall not exceed the following:

For 2500 Sq.mm		
a)	At conductor screen	**8 KV/mm**
b)	At the insulation screen	**4 kV/mm**

The dielectric stress at 127 kV shall be furnished by the bidder with calculation sheet.

6.05.0 The cable shall be designed to have a minimum useful life of not less than fifty years. The cable manufacturer should submit a graph showing the breakdown voltage with respect to time for the XLPE insulation compound used. In addition the type of XLPE semi-conducting compound used should be indicated i.e., whether super smooth and purity level.

6.06.0 Each cable length shall be provided with a pulling socket, pulling eye, which shall be fitted to pulling end to withstand the maximum pulling force.

6.07.0 Copper wire screening shall be preferably before the lead sheath to ensure specific water tightness of cable both transversely and longitudinally. However other types of placement of the copper wire screening is also acceptable if it meets the overall technical requirements. The same shall be

established by way of Type Test Reports conducted on such cables.

The bidder shall indicate any specific construction features, which will be provided to ensure specific water tightness of cable both transversely and longitudinally.

6.08.0 CURRENT RATING:

The bidder shall furnish the continuous current ratings in ground, in air, in pipes and in ducts at the maximum conductor temperature of 90^0C with reference to the ambient site conditions on the guidelines of IEC 60287. Any additional data, other than furnished under climatic conditions and operating conditions may be suitably assumed. However, the same shall be furnished in GTP for reference. The ratings shall be for Trefoil touching formation when the sheaths are single point bonded and both ends bonded or cross bonded (without exceeding the stipulated sheath voltage of **65 volts** or undue high circulating currents).

The current ratings shall be for single circuit/double circuit in operation.

The bidder shall also furnish technical information on:

i) Derating factors for various types of installation conditions in trefoil and flat (viz., depth of laying, varying ground temperatures, cables in ducts / pipes, cable spacings, circuit spacings, varying soil thermal resistivities etc.) shall be furnished by the bidder for the following conditions:

(a) Proximity to other 220 kV cables.

- Variation of number of cables (max. 12 in number).
- Variation in spacing.
- Variation in loading of the cables (80% to 100%).

(b) Variation in depth of water table.

(c) Depth of laying cables in trenches and cable ducts.

(d) Depth of **Stabilised Thermal Backfill (STB)** below and above laid cables.

(e) Width of trench on either side of the cables in which **STB** will be put.

(f) Variation in STB effective thermal resistivity.

(g) Variation in soil thermal resistivity.

(h) Laying of cables in long lengths of HDPE pipe, 19 mm thick – Variation due to size and thickness of pipe and open space available in pipe – BIDDER shall suggest methods to improve the ratings.

ii) Short Time Current Loading:

The current loading permissible for a defined period of short time operation, over the cyclic load as under.

Cyclic loading over a 24 hour period.

2100	to	0600 Hours	(9 Hours)	**50%**
0600	to	0900 Hours	(3 Hours)	120%
0900	to	1800 Hours	(9 Hours)	**100%**
1800	to	2100 Hours	(3 Hours)	120%

Furnish short time loading for the following conditions.

i) Only one circuit is live.

ii) When both circuits are live.

When cables are laid in trefoil touching formation.

i) Single point bonded.

ii) Both end bonded.

iii) Cross bonded.

The bidders should furnish GA drawing/other details with supporting calculations on charging current, capacitance, inductance, losses, sheath voltages, sheath currents, surge impedance, sequence impedance and screen factors, detailed drawings etc., along with the bidding documents.

6.08.1 MECHANICAL CHARACTERISTICS OF CABLE:

The cable shall withstand the electromechanical forces due to peak short circuit currents of **125KA** and shall withstand the stresses of thermal expansion in the insulation due to faults. The cable shall withstand the mechanical stresses during installation.

6.09.0 TEMPERATURE RISE:

The maximum conductor temperature shall not exceed 90^0C during continuous operation at full rated current at 220 kV followed by 20% overload for three hours, maximum temperature not exceeding 130^0C. The temperature after a short circuit for one second shall not exceed 250^0C, with initial conductor temperature of 90^0C.

6.10.0 EMERGENCY LOADING:

The BIDDER shall indicate the maximum percentage overload current that the cable can carry and its duration when operating initially at a conductor temperature of 90^0C and the permissible final conductor temperature after overload. The total period during the lifetime of the cable when it shall be subjected to emergency loading without affecting the expected life of the cable shall also be indicated.

6.11.0 CYCLIC RATING:

The BIDDER shall also indicate the percentage overload current that the cable can carry and its duration, without the conductor temperature exceeding 90^0C due to the time lag in conductor temperature change on account of the change in thermal characteristics of the mass of the soil surrounding the cable.

6.12.0 CABLE MATERIAL

a) Conductor:

Plain annealed high conductivity copper wires, stranded, segmental conductor while conforming to IEC-60228. The Copper used for the conductor shall be of highest purity. The minimum number of wires and conductors and DC resistance of conductor shall be as per IEC-60228.

b) Conductor Screen:

The conductor screen shall be provided over the conductor by extrusion of semi-conducting compound or by a combination of semi-conducting tape/s and extruded semi-conducting compound. The minimum thickness, excluding tape/s shall be 1.5 mm.

c) Insulation:

Cross-linked polyethylene insulation by dry curing process shall be provided over the conductor screen. The nominal thickness of 24.00 mm and subject to tolerance as per IEC-62067, Clause 10.6.2.

The insulation shall be of high quality, and shall be as far as possible free from contaminants, moisture and voids. The size of voids and contaminants shall be within limits of recognized National/IEC Standards.

The insulation shall be suitable for operation in wet or dry locations at conductor temperature not exceeding 90^0C for normal operation, 130^0C for emergency over load of short duration, and 250^0C for short circuit conditions.

d) Insulation Screen:

Shall be by extruded semi conducting compound and of minimum thickness 1.0 mm.

The semi conducting screens shall be suitable for the operating temperatures of the cable and compatible with the insulation.

e) Moisture Barrier (Longitudinal):

This shall be semi-conducting synthetic non-woven tape with suitable swellable absorbent for longitudinal water sealing covering the whole surface area of the non-metallic part of insulation screening. This barrier shall restrict longitudinal water penetration under the metallic sheath. The nominal thickness of water blocking tape shall not be less than 0.3 mm.

f) Metal Sheath/Moisture Barrier (Radial):

Shall be extruded lead alloy 'E' sheath.

The nominal thickness of lead alloy sheath shall be 3.0 mm and shall meet the Electrical and Mechanical properties as per standards. The minimum thickness shall be as per IEC-62067 (Clause 10.7.1).

g) Bedding Tapes:

Suitable semiconducting bedding tapes shall be used under metallic screen of approximate thickness 0.3 mm.

h) Metallic Screen (Armour):

The metallic screen shall be of non-magnetic plain copper round wires, helically applied over the semiconducting bedding tape/s.

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

Note: Requirement of Metallic Sheath/Screen:

The metallic screen can be before or after the lead sheath. However, it shall be as per the manufacturer's type tested design.

The cross section of the metallic sheath that is lead sheath in combination with plain copper round wire screen shall be designed to meet the following requirements:

i) Sustaining the system short circuit rating of **50 KA** for 1 Sec.

The temperature of metallic sheath at the time of short circuit (cable operating at maximum conductor temperature) shall be indicated in the short circuit calculations of the design of metallic screen/lead sheath.

ii) Ensuring mechanical protection of the cable.

iii) Ensuring radial water tightness of the cable.

Note: Test report ensuring the above compliance has to be submitted by the bidder along with the bid.

i) Outer Sheath:

The outer sheath shall be extruded Black colour High Density Polyethylene, type ST 7 conforming to requirement of IEC. The High Density Polyethylene compound used shall be brand new from a reputed manufacturer and in no case shall recycled material be used.

The outer sheath shall be designed for protection against termite and rodent attacks by adding suitable additives to HDPE compound and such additives shall be harmless to operating personnel. The minimum thickness of outer sheath shall be 3.5 mm.

j) Coating:

A hard baked on layer of graphite shall be applied over the sheath as outer electrode for testing the sheath.

6.13.0 IDENTIFICATION

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

Brand Name of Manufacturer:

Year of Manufacture:

Voltage rating / conductor cross section: 220,000V/2500 Sq.mm

K.P.T.C.L.

XLPE

7.00.0 CABLE ACCESSORIES:

7.01.0 GENERAL:

Following are the accessories required.

(a) Straight through normal as well as cross bonded joints suitable for directly buried in ground conditions/RCC Cable Ducts.

(b) Outdoor type cable end terminations/GIS module plugin type.

The above accessories shall be suitable for the 127/220 kV, single core 2500 Sq.mm copper conductor lead sheathed cable. The detailed cable construction is given in these specifications under clause 5.01.00

7.02.0 TECHNICAL REQUIREMENTS:

The accessories should be compatible with the size of the conductor, the insulation and the voltage class of the cable. The components of the accessory shall not be affected by contact with the component materials of cable, and shall not corrode any metal, which they come in contact. The accessory, in the assembled condition, shall be capable of operating under the normal and fault temperature conditions of the cable.

The cable accessories should be procured only from reputed manufactures & type test reports shall be submitted along with the bid.

7.02.1 CABLE JOINT:

The Cable joints shall be suitable for 220 kV Single Core, 2500 Sq.mm copper conductor, lead sheathed XLPE cable and conforming to relevant IEC specification.

The joints shall be suitable for size of the conductor, the insulation, voltage and current ratings of the cable. The required service conditions are horizontal installation, directly buried in earth, laid in RCC cable duct and intermittently or continuously submerged in water.

The BIDDER shall quote for the required quantity of prefabricated type Cable joints which shall comprise of a Factory Tested One Piece Pre Moulded Silicone Rubber joint body moulded from a special Silicone Rubber formulation to provide perfect compression force for optimized electrical performance and afford very simple, reliable, consistent installation. Conductor Jointing should be either with mechanical connectors or a proven crimping technique. Outer mechanical protection with integrated moisture protection must be provided and the manufacturer must provide a detailed description of this. Solderless Jointing technique for the lead sheath and copper wire screen must be provided. Further, the straight through joint shall be able to

(i) Provide a seal against the entrance of moisture or external environment.
(ii) The assembled joint should be resistant to corrosive agents present in the soil, should be mechanically strong to withstand pressure, bending, pulling fatigue. The joint should withstand

temperature variations under normal load and fault conditions.

7.02.2 OUTDOOR CABLE END TERMINATION:

The cable end terminations shall be outdoor type suitable for 220 kV SC, 2500 Sq.mm copper conductor, lead sheathed XLPE cable and shall be designed to perform under severe environmental conditions and also conform to the relevant IEC Specifications.

The outdoor termination should have a pre moulded silicone rubber stress cone to provide the electrical stress control function at the end of screen/shield and should be easily applied without tools It should avoid partial discharges and surface corona under severe service conditions. The cone should be placed on the cable terminated within a pressure tight composite housing made of glass fibre reinforced resin tube with silicone rubber sheds moulded to the tube. The interface between the stress cone, cable insulation and inner housing must be filled with a silicone oil poured from the top. No heating of the silicone oil prior to pouring should be required. It should seal any ingress of atmospheric elements. A flexible double sealing system which is installer friendly must be provided to provide protection against environmental influences. An oil resistant barrier must be provided over the conductor to prevent any oil migration the total creepage distance shall not be less than 6125 mm.

The outdoor termination shall be suitable for the insulation, voltage, conductor size and current rating of the cable.

The sealing ends shall conform to the latest International Standards and shall be of thoroughly proven design. The outdoor type sealing ends shall be suitable for installation in polluted atmosphere referred to in clause 4.00.00 and shall be completely weather proof. Each outdoor type-sealing end shall be supplied complete with four mounting plate insulators to insulate the sealing end from the supporting structures and to control the sheath current. All metallic fittings must be made of corrosion resistant aluminium alloy. Terminal connectors and bimetallic clamps shall also be supplied. Each sealing end shall be provided with consumable materials such as wipes and solvent for cleaning. A Cable Gland for the shield connection and lead sheath connection must be provided and this should be sealed from the external environment with a heat shrinkable sleeve. The power cable leading to sealing end shall be provided with proper sunshield cover.

The material for the housing of the termination should be resistant to tracking, ultra violet radiation (U.V. Exposure) weathering and should have stable hydrophobic properties.

The bidder shall provide necessary arrangement to limit flow of current in the structure supporting the sealing end.

The sealing ends shall withstand the power frequency, impulse and cable

testing voltage after installation as specified.

The cable and accessories shall withstand all thermal and mechanical stresses under steady state and transient operating conditions.

7.03.0 TECHNICAL ASSISTANCE/TRAINING:

The successful bidder shall arrange with the suppliers of cable joints and / or terminations, the technical assistance in jointing / terminating the cable during installation at the site. The successful bidder shall arrange to train the owner's personnel in jointing and terminating techniques during the installation.

7.04.0 LINK BOXES:

7.04.1 Link Boxes along the run of the 220 kV Cable:

a) Link boxes for grounding of the sheaths of single core cables along the run of the cables shall be made of cast iron/aluminium alloy/stainless steel, suitable for direct burial in the same ground conditions as the cable with anti-rust protection suitable for completely underground installation and for operation when immersed in water. The link box shall conform to IP-66 degree of protection for which the test reports shall be furnished.

   The bidder shall furnish a copy of type tests certificates for the link box offered as per the specification from any of the laboratories indicated in Cl.No. 10.02.10 or any other NABL Accredited Laboratories.

   The design of the box must include a top Lid, which can be lifted vertically. BIDDER to submit the detailed drawing of these boxes along with the Bid. These Link Boxes shall be easily accessible from road surface in case of installation in joint pit. The box shall ensure complete water tightness.

b) These Link Boxes shall be suitable for terminating the cable sheaths on either side of joint bays based on cable route for cross bonding at the box as well as for earthing at recommended locations.

c) All accessories such as copper terminals, cable lugs, connecting links, disconnecting links, washers, gaskets, mounting arrangements, etc., shall be provided to make the system complete.

d) The cross bonding link box shall be designed to be completely water proof and capable of immersion in water.

e) The cable leads from sheath to link box, capable of withstanding 10 kV

DC and cable leads from link box to earth shall also be in BIDDER's scope of supply. The BIDDER shall quote for the type of cable leads for the cross bonding system as per the following design:

Concentric bonding leads of suitable size corresponding to three-(3) nos. co-axial cable entries to the cross bonding box.

Non–linear resistor type surge divertors of metal oxide type, wherever required, shall be provided in the link box by the BIDDER.

f) The BIDDER may quote for link boxes of suitable design in which the surge voltage limiters (SVLs) do not need to be disconnected when a routine 10 kV DC test on the cable outersheath is performed.

7.04.2 Link boxes at the circuit end:

The lead sheath shall be grounded through suitable disconnecting links at the base of sealing ends. The BIDDER shall clearly indicate whether the links are to be grounded directly or through SVLs (non-linear resistors). The links shall be housed in a weather proof, outdoor, galvanised sheet steel box or cast iron or aluminium alloy box with mounting brackets and provided with 'O' Ring gasketted door. The cable leads from the sheath to the link box, capable of withstanding 10 kV DC & cable leads from link box to earth shall form a part of the scope of supply of the BIDDER. The Bidder shall quote for the same.

7.04.3 Cross Bonding of cable sheath:

The BIDDER shall give his recommendations regarding cross bonding of cable sheaths for the flat formation of single core cables. The BIDDER shall clearly indicate the number of joints to be directly earthed and those to be earthed through zinc oxide (Z_nO), non-linear resistors (sheath voltage limiters). The offer may indicate a suitable design whereby Z_nO resistors need not be disconnected while conducting routine DC test on the over sheath.

The sheath standing voltage to earth for rated cable current shall not be in excess of 65 V RMS.

The sheath voltage, during an external three phase, symmetrical through fault as specified, should not be in excess of 3.3 KV for 3 sec.

The BIDDER shall indicate the arrangement considered by him in his proposal to meet the above requirements with suitable non-linear resistors, if required, to limit the sheath voltage.

Detailed calculations for sheath voltages as per recommended bonding methods shall be furnished along with the bid.

The BIDDER shall indicate permissible variation in the lengths of the 3 minor

sections of a major section, which will not affect the efficacy of the cross bonding.

The BIDDER shall confirm that the cable can be continued in service in the event of a sheath fault and shall indicate the de-rating of the cable in case of an earth on the sheath at the link box earthed through SVLs.

Transposition of cables:

The BIDDER shall indicate and provide arrangement for transposition of cables if necessary along with cross bonding. The Details of the same shall be furnished alongwith the bids.

7.04.4 VOID

7.04.5 VOID

7.04.6 Partial Discharge (PD) Measurement System: VOID

7.05.0 DTS (Distributed Temperature Sensor) with RTTR: void

7.06.0 SHEATH BONDING CABLE AND EARTHING CABLE:

The sheath bonding cable shall be co-axial cable 6.6 kV and above grade with 400/400 Sq.mm (conductor/concentric conductor) stranded Copper conductor PVC insulated wire armoured and PVC sheathed. The earthing cable shall be 3.3kV & above grade with 400Sq.mm stranded copper conductor PVC insulated & PVC sheathed. However the rating and the size of sheath bonding cable and earthing cable mentioned are indicative and minimum values. The bidder may quote the actual rating and size of cable offered, to meet the requirement.

7.07.0 PIPE EARTH STATIONS:

The earthing shall be as per provisions of IS:3043, Code of practice for earthing and as per IE rules:1956 Or its Latest Amendments.

8.00.0 ELECTROLYSIS AND CORROSION:

The cable serving shall be designed such that the cable sheath and armouring are protected from electrolysis caused by stray currents, from galvanic action and from corrosion and microbiological attack. The design of accessories shall be such that the outer metallic coverings of cable joints, sealing ends and control points can be insulated from earth along the entire route so that cathodic protection, if needed can be applied and also periodic testing of the insulating resistance of the serving can be

done. A set of links shall be provided at each end of cables to connect the cable sheath and armour to the respective station grounds. The sealing ends shall be suitably insulated from their supporting structures, to permit insulation test on the cable over sheath.

9.00.0 GROUNDING SYSTEM:

The BIDDER shall indicate his recommendations regarding the type of grounding systems for the lead sheath/armour. The scope of supply shall include ground rod or ground conductor as recommended. The grounding material shall be copper.

10.00.0 TESTS ON CABLES AND ACCESSORIES:

10.01.0 APPLICABLE STANDARDS:

The testing procedures and requirements shall conform to the latest edition of the following national and international standards, but not limited to:

a) IEC publication 60540
b) IEC publication 60228
c) IEC publication 60229
d) British Standard Specification 6622
e) IEC publication 60840 ***(only applicable Sections of the Standard)***
f) IEC publication 60230
g) IEC publication 60287
h) IEC publication 60811
i) IEC publication 60885
j) IEC publication 62067

The IEC Standards shall prevail whenever the same tests are specified in other standards.

10.02.0 TESTS:

10.02.1 The Owner is keen to procure cables of highest integrity. To provide adequate confidence to the owner for the long term reliability of the cables, the manufacturer has to carry out the prequalification tests on cables and their accessories in accordance with IEC-62067:2011.

The prequalification tests should have been conducted on complete cable

system as per clause 13 of IEC-62067.

Prequalification test report shall be furnished along with the bid documents, which is mandatory.

The prequalification tests are to determine long term reliability of a cables system. Hence it is necessary to carry out a long term accelerated ageing test. This test is to be performed as per clause no. 13.2 of IEC-62067 on the complete system comprising cables (specified in Tender) joints and termination in order to demonstrate the performance of the system.

The bidder shall enclose a detailed report of prequalification test as per clause No.13.2 of IEC-62067 along with the bid.

After qualification of these tests, regular routine, acceptance and type tests are to be conducted in any one of the approved labs as indicated in the clause 10.02.10 on the samples and cables manufactured for the Owner.

10.02.2 The bidder shall include the field test report of similar size and voltage class cables installed in actual service. The report shall include voltage class, size, actual voltage, actual load current data, sheath voltage, sheath/conductor temperature data and all events after installation during service of such cable till date etc.

10.02.3 Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests in the activity schedule.

10.02.4 Acceptance tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of the lot.

10.02.5 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the cable to check requirements, which are likely to vary during production and to demonstrate the integrity of the cables to be delivered to the customers for use.

10.02.6 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Bidder to ensure the desired quality of the end product to be supplied by him.

10.02.7 The Standards and norms to which these tests will be carried out are mentioned elsewhere in these specifications. Where a particular test is a

specific requirement of this specification, the norms and procedures of the test shall be mutually agreed to between the Bidder and the Owner in the Quality Assurance Programme.

10.02.8 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Supplier in the proforma for "Guaranteed Technical Particulars", furnished in this Specification or acceptance value specified in this specification, whichever is more stringent for that particular test.

10.02.9 All tests – routine, acceptance and type tests shall be as per IEC-62067 and its Latest Amendments.

10.02.10 The adequacy of Partial Discharge detector used for Partial Discharge tests required for drum lengths of cables under routine tests must be demonstrated by performing tests as per IEC-60885 (3) – 1988.

The bidder shall furnish a copy of type tests certificates for the cable and accessories offered as per the specification from any of the following laboratory on similar cable and accessories as offered for this tender in compliance with IEC:62067, CL.No.12.2: Range of Type approval. The test should have been conducted within the last 10 years as on the last date of submission of bid. No charge is payable by the owner for the type tests.

a) For cables & accessories manufactured in India:

i. Type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by Government or accredited by National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.

ii. Type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.

iii. The type tests conducted in-house by manufacturers shall also be acceptable where the specific test facilities are not available in independent NABL accredited laboratories provided the lab (manufacturer's) is accredited by National accreditation body of the country and the tests have been witnessed by a representative of NABL accredited Independent laboratory/Power utility.

b) For cables & accessories manufactured Abroad:

i. Type tests on imported equipment should have been conducted in an Indian laboratory or foreign laboratory accredited by National accreditation body of respective country.

ii. Type tests conducted in-house by manufacturers shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests have been witnessed by a representative of accreditation body/Power utility.

10.02.11 Following are the type test reports which are to be enclosed/uploaded in the bid.

1) Prequalification test – (Cl. 10.02.1 of specification)
2) Electrical Type tests as per – (Cl. 10.03 (1)(a) to (j) of specification).
3) Non-Electrical Type tests as per – (Cl. No. 10.03 (2) (a) to(o) of specification).
4) Special test as per- (Cl. 10.06 (a) (i) & (ii) of specification)
5) Type test for Link box- (Cl. No. 7.04.1 of specification)

10.02.12 Tests to be conducted during the supplies/after completion of supplies for acceptance of cable and accessories will be at the discretion of the Owner.

1) CABLE:

The owner will select at random a test sample of cable from the lot and subject it to **either a particular type test or** full range of type tests as per IEC-62067: 2011 at any reputed testing house or Laboratory or at manufacturer premises to be approved by KPTCL.

The bidder shall prepare the sample for tests and organize testing.

The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner.(Refer Note (e) given below).

If the cable fails in any of the type tests, the entire lot of cable will be rejected.

2) JOINTS & TERMINATION:

Two Terminations and one joint will be selected at random out of the supplies and subjected to **either a particular Type test or** full range of type and other tests at any reputed testing house/laboratory to be approved by KPTCL as per Clause IEC 62067: 2011 and tests shall be carried out accordingly.

The bidder shall prepare the sample for tests and organise testing. The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner.(Refer Note (e) given below).

If the sample under test i.e., cable / joint / termination fails, the entire lot of cable / joint / termination will be rejected.

3) The tests mentioned in (1) & (2) above are independent of the type test reports already furnished by the supplier.

NOTE:

(a) The waival of any type tests shall be at the sole discretion of the owner.

(b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

(c) The cost towards each type test shall be clearly indicated seperately in the bid and the same will be included for bid evaluation.

(d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

(e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected.

The type test charges shall be paid upfront by the firm/bidder even though the same is on the behest of KPTCL. However such type test charges as per actuals shall be reimbursed to the firm/bidder in case the cable passes the type tests successfully. Type test charges will not be reimbursed if the cable fails in the type test.

10.03.0 TYPE TESTS ON CABLE SYSTEM (CABLES & CABLE ACCESSORIES):

The following type tests comprising the electrical tests on the completed cable and the appropriate tests on the cable components shall be conducted in any of the laboratory to be approved by KPTCL in the presence of the owner's representative.

The owner may at his discretion, waive the type tests, modify the tests, request for additional tests.

1) The type tests and sequence of electrical test (as per following clauses of IEC 62067) on complete cable system shall be:

a) Bending Test on the cable (Cl.12.4.3) followed by installation of accessories and a partial discharge test at ambient temperature

(Cl. 12.4.4)

b) Tan Delta measurement (Cl:12.4.5)

c) Heating cycle voltage test (Cl:12.4.7)

d) Partial discharge test (Cl:12.4.4)

- at ambient temperature, and

- at high temperature.

The tests shall be carried out after the final cycle of item (c) above or alternatively, after the lightning impulse voltage test in item (f) below.

e) Switching impulse voltage test (required for Um ≥300kV Cl.12.4.7.1)

f) Lightning impulse voltage test followed by a power frequency voltage test (Cl.12.4.7.2)

g) Partial discharge tests, if not previously carried out in item (d) above.

h) Tests of outer protection for joints (Refer annexure G):

i) Examination of the cable system with cable and accessories on completion of the above tests (Cl. 12.4.8)

j) The resistivity of the cable semi-conducting screens (Cl. 12.4.9) shall be measured on a separate sample.

2) The Non Electrical type tests (as per the following clauses of IEC 62067) on cable components & on completed cable shall be:

a) Check the cable construction (Cl. 12.5.1)

b) Tests for determining the mechanical properties of insulation before and after ageing (Cl. 12.5.2)

c) Tests for determining the mechanical properties of oversheaths before and after ageing (Cl. 12.5.3)

d) Ageing tests on pieces of complete cable to check compatibility of materials (Cl. 12.5.4)

e) Pressure test at high temperature on oversheaths (Cl. 12.5.6)

f) Hot set test for EPR and XLPE insulations (Cl. 12.5.10)

g) Measurement of density of HDPE insulation (Cl. 12.5.11)

h) Measurement of carbon black content of black PE oversheaths (ST3 and ST7) (Cl. 12.5.12)

i) Test under fire conditions (Cl. 12.5.13)

j) Water penetration test (Cl. 12.5.14)

k) Tests on components of cables with a longitudinally applied metal type or foil, bonded to the oversheath (Cl. 12.5.15)

Note: All the applicable tests as per IEC-62067 shall be conducted for the cable requirement of this specification.

10.04.0 ROUTINE TESTS ON CABLE AND ON THE MAIN INSULATION OF PREFABRICATED ACCESSORIES:

The following tests (as per following clauses of IEC-62067) shall be carried out on each manufactured length of cable:

a) Partial discharge test (Clause 9.2).

b) Voltage test (Clause 9.3).

c) Electrical test on over sheath of the cable (Clause 9.4).

d) Conductor resistance test (Clause 10.5).

10.05.0 ACCEPTANCE TEST / SAMPLE TESTS ON CABLES:

The following tests (as per following clauses of IEC-62067) shall be carried out on samples.

a) Conductor examination (Clause 10.4).

b) Measurement of electrical resistance of conductor and of metal screen/sheath (Clause 10.5).

c) Measurement of thickness of insulation and oversheath (Clause 10.6).

d) Measurement of thickness of metallic sheath (Clause 10.7).

e) Measurement of diameters, if required (Clause 10.8)

f) Hot set test for XLPE and EPR insulation (Clause 10.9).

g) Measurement of capacitance (Clause 10.10).

h) Lightning impulse voltage test (Clause 10.12).

i) Water penetration test, if applicable (Clause 10.13)

Note: All the applicable acceptance tests/sample tests as per IEC-62067 shall be conducted for the cable requirement of this specification.

Frequency of Acceptance Tests:

The acceptance tests shall be conducted on one drum length from each manufacturing series of the same type and size of cables, but shall be limited to not more than 10% of the number of drum lengths, rounded to upper unity. However, water penetration test & lightning impulse test shall be on one length for the order upto 20Kms and two lengths for more than 20kMs order.

10.06.0 (a) SPECIAL TESTS ON CABLES:

The following are the additional special tests:

i) Short circuit test on metallic wire screen and lead sheath, in combination at 50kA for 1 Sec with conductor temperature during the test at 90^0C.

ii) Test for ovality of the core.

iii) (a) The waival of type tests shall be at the sole discretion of the owner.

(b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

(c) The cost towards type tests shall be clearly indicated in the bid and will be included for bid evaluation.

(d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected

10.07.0 SPECIAL TEST ON ACCESSORIES:

10.07.1 JOINTS

Cyclic ageing test under water.

The Test shall be conducted as per IEC 62067 Annexure – G

10.07.2 OUTDOOR TERMINATION:

The outdoor termination should meet the following additional test requirements

(i) Power frequency voltage wet withstand test as per latest version of IEC-62067 standard.

(ii) Salt fog test as per IEC.

(iii) Material test (if applicable)
   a) Tracking and erosion resistance
   b) Thermal ageing
   c) Weather resistance

10.08.0 ADDITIONAL TESTS:

Following tests shall be carried out as per IEC-62067: 2011, Cl. No. 16.0 on the complete installation after completion of cable laying, jointing and providing all necessary accessories.

a) Insulation resistance test.
b) DC voltage test of over sheath & AC voltage test of the insulation in accordance with IEC-62067: 2011 (Cl. No. 16.2 & 16.3).
c) Site tests on non-metallic sheaths in accordance with latest version of IEC-60229.

The supplier shall also indicate any additional special test at site recommended by them to ensure satisfactory operation.

10.08.1 The Bidder shall furnish all the testing details in a compact disc (CD).

10.09.0 **GUARANTEED LOSS:**

Regarding guaranteed losses, measured losses and capitalization of losses for the purpose of evaluation of the offer refer respective clause in SCC of bid document.

11.00.0 IDENTIFICATION:

The Cable should be identified by embossed letters in English as per Clause 6.13 of technical specification.

The accessories shall be marked with voltage class, size of cable conductor, manufacturers name or trademark, date of manufacture and relevant technical information.

12.00.0 QUALITY ASSURANCE PLAN:

a) The bidder shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i. Structure of the organization.

ii. The duties and responsibilities assigned to staff for ensuring quality of work.

iii. The system of purchasing, taking delivery and verification of materials.

iv. The system for ensuring quality of workmanship.

v. The quality assurance arrangements shall conform to the relevant requirement of ISO-9001 or ISO-9002 as applicable.

vi. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of suppliers representative, copies of test certificates.

vii. List of manufacturing facilities available.

viii. Manufacturing process shall be fully automatic with dust proof/Air conditioned working atmosphere.

ix. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

x. List of testing equipment available with the bidder for final testing of equipment specified and test plant limitation, if any vis-à-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the “Schedule of Deviations” from the specified test requirements.

xi. Level of automation achieved & test of areas where manual processing exists.

b) The Successful bidder shall within 30 days of placement of order, submit the following information to the Owner.

i. List of raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with

the offer.

ii. Type test certificates of the bought out accessories if required by the Owner.

iii. Quality Assurance Plan (QAP) with holds points for owner inspection. QAP and owners hold points shall be discussed between the owner and successful bidder before the QAP is finalized.

iv. The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing if required by the owner and ensure that the quality assurance requirements of specifications are followed by the sub-contractor.

c) The Quality Assurance Programme shall give a description of the Quality System and Quality Plans with the following details:

i. Quality System

- The Structure of the organization.
- The duties and responsibilities assigned to staff for ensuring quality of work.
- The system of purchasing, taking delivery and verification of materials.
- The system of ensuring quality workmanship.
- The system of control of documentation.
- The system of retention of records.
- The arrangement of successful bidder internal auditing.
- A list of administrative and work procedures required to achieve successful bidder quality requirements. These procedures shall be made readily available to the Owner for inspection on request.

ii. Quality Plans:

- An outline of the proposed work and programme sequence.

- The structure of contractor's organizations for the contract.
- The duties and responsibilities ensuring quality of work.
- Hold and notification points.
- Submission of engineering documents required by this specification.
- The Inspection of the materials and components on request.
- Reference to successful bidder work procedures appropriate to each activity.
- Inspection during fabrication/construction.
- Final inspection and test.

The Owner reserves the right to seek documentary proof of the source of material (insulation, outer sheath, and other cable components) and to cross check with the supplier.

13.00.0 INSPECTION:

Inspection may be carried out by the owner at any stage of manufacture. The successful bidder shall grant free access to the owner's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the owner shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the owner informed in advance about the manufacturing programme so that arrangement can be made for inspection.

13.01.0 The owner can depute upto Five Engineers from KPTCL for inspecting the equipments/materials. The Visa, to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the Contractor.

13.02.0 The owner reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items.

13.03.0 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested in presence of the owner's representative and cleared for despatch.

13.04.0 The supplier shall give 30 days advance intimation to enable the owner to depute his representative for witnessing type tests, acceptance and routine tests.

14.00.0 PACKING AND MARKING:

14.01.0 DELIVERY LENGTH OF CABLE:

It is important to note that the correct delivery length on each drum and the total number of drums to be delivered shall be ascertained by the successful bidder before manufacture, by cable route survey and approval of the owner.

The inner diameter of the drum shall not be less than 20 D and the minimum delivery length of the cable on each drum shall be approximately 500 Mtrs (Five Hundred) subject to approval of the owner.

14.02.0 The cable shall be wound on non-returnable strong steel drums. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks. The ends of the cable shall be sealed with good quality heat shrink sealing caps. The required additional sealing caps of sufficient quantity shall be supplied for use for testing during laying and jointing at site and to seal spare lengths of cable.

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

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

(i) Name and address of the Manufacturer, Trade name/Trade Mark/Brand.

(ii) Size of cable (cross section) rated voltage, standard, insulation, cable code, drum number, year of manufacture.

(iii) Length of cables (metres).

(iv) Direction of Rolling.

(v) Net weight (in Kg).

(vi) Gross weight (in Kg).

(vii) Purchase order reference.

Note: a. Economic drum length shall be got approved from the owner during the survey of route by the successful bidder and inner drum diameter shall not be less than 20 D.

b. Each cable end shall be hermetically sealed by means of metal cups using wiping lead so as to protect the cable from moisture penetration during transit, storage and laying. Pulling tension shall be furnished by the

successful bidder.

c. The vendor shall be responsible for any damage to the cables during transit due to cable or reels not having been properly fastened, packed and secured.

d. Two Nos. of swivels of suitable capacity shall be supplied along with the first batch of cables free of cost.

e. The maximum weight of cable along with drum to be furnished by the successful bidder before execution of works.

Handling and Storage:

All accessories and spares shall have a minimum shelf life of 10 years, detailed instructions for storing accessories and all equipments which are supplied by the vendor shall be indicated.

15.00.0 DESPATCHES:

No dispatches shall be made without approval from the Owner to the test certificates. All dispatches shall be made to the consignees intimated by the owner.

16.00.0 CABLE LENGTHS:

The correct total quantity, the number of drums, the length of cable on each drum shall be ascertained by the successful bidder from the owner, at the time of manufacture. This is in view of any change in the already finalized route plan, profile which may arise due to any unforeseen circumstances between the period of placing the order and commencement of manufacture.

17.00.0 DELIVERY AT STORES/SITE STORES:

The stores / site is located at Bangalore. All regulations governing the transport of goods by various modes of transport shall be observed by the contractor.

It will be the sole responsibility of the successful bidder to deliver the goods safely at the owner's stores / site stores, including handling and unloading etc.,

18.00.0 INSTALLATION:

18.01.0 SURVEY – ROUTE PLAN:

18.01.1 The bidders are requested to fully inform and acquaint themselves on the local site conditions, which have a direct bearing on the cost estimates and execution of the work.

The tentative cable route plan is furnished to the bidder, indicating roads, position of road crossings, railway crossings, drainage crossings etc., in the drawing enclosed with the bidding document. In case of Variations during actual survey or any deviations in quantity, payment would be made as per quantities executed as per actuals.

The successful bidder shall make a detailed survey of the cable route, by excavating the trial pits as warranted by the local conditions and prepare necessary drawings. All relevant data, required shall be properly recorded and preserved for future use and to decide on requirements of:

- Cable delivery length per drum
- Proposed cable sections
- Location of joint bay positions
- Type and quantity of joints required
- Final cable route plans
- Design of cable ducts/trench for road crossings drainage crossings, railway crossings etc.
- Identify locations for bonding.
- Trench with brick masonry side wall and pre-cast reinforced concrete slabs.

The survey data on the cable route should also include recording of the information required for cable design, such as

- Type of soil along the cable route, soil resistivity
- Soil thermal resistivity, PH Value
- Sub soil water locations and other relevant information in designing the ducts and pipes for cable.

NOTE: The quantities executed will be paid at actuals.

18.01.2 LOCATION OF JOINT BAYS:

The location of the joint bays should be carefully decided to avoid, traffic hazards, collection of subsoil water and any possibility of flooding due to storm waters. The joint bays located should be easily accessible for inspection and tests.

18.01.3 CABLE LENGTH, SECTIONS:

The maximum and minimum delivery lengths of cable that can be supplied shall be furnished by the bidder in the tender.

The successful bidder shall carryout a final route survey, fix joint bay locations and finalize the sections and delivery lengths.

A tolerance of ±1% may be assumed while finalizing the actual cable length.

The work on installation and laying of cables will be taken up by the successful bidder only on approval of the route plans by the owner.

18.01.4 CABLE INSTALLATION RECORDS:

The route plan records / drawings, and the final route map drawings after installation and commissioning, should be furnished to the owner. Three transparencies and nine zerox copies each of route plan and 2) Final route map after installation shall be furnished. Soft copy of the same shall be furnished in CDs.

18.01.5 For preparation of cable route plans and cable records, relevant sections of Indian standards publication IS:1255, “Code of Practice for installation and maintenance of power cable”, or any other appropriate international standard may be referred for guidance.

18.01.6 SOIL THERMAL RESISTIVITY / SOIL RESISTIVITY:

The successful bidder shall investigate the soil characteristics along the cable route, at the required laying depths to evaluate the parameters governing the cable design.

The thermal resistivity tests should be carried out at every 200M interval along the cable route and also at specified locations at the direction of the owner. At each location the thermal resistivity tests are to be taken at three different depths and two soil samples are to be taken for further laboratory analysis.

The laboratory analysis of the soil samples collected from the site should be conducted in detail, including soil identification, moisture content, density, organic content, critical moisture content of each soil type encountered along the route to arrive at the thermal resistivity values of the native soil.

These tests should be conducted by using reliable measuring instruments with fully automated thermal property analyser and thermal probes, through reputed agencies, like GEOTHERM, CPRI, Technical Institutions & any other competent organisations. KPTCL will depute its Engineers to witness these tests.

The generally assumed value of the soil thermal resistivity may be taken as 150^0C Cm/w.

The OWNER anticipates the presence of soil strata at a few locations along cable routes with a soil thermal resistivity of more than 150^oC Cm/w.

However, the successful BIDDER shall be responsible to ensure that no derating of the cable will take place on account of variation in soil thermal characteristics. In consultation with the OWNER, the BIDDER shall analyse and indicate the appropriate backfill (STB – Soil Thermal Backfill) recommended. Bidder will have to design the trench optimally to take care of local site conditions. The maximum permissible soil thermal resistivity shall be limit to 120^{O}C Cm/w in fully dried condition out of the locally available materials to achieve maximum current capacity for the cable section used. BIDDER shall ensure that no derating of the cable takes place on account of soil/backfill thermal characteristics and that proper backfill is used.

In conformity with the above requirement, the BIDDER shall determine and advise on the following:

- Optimum design of trench to take care of local hot spots and methods to reduce effective Thermal resistivity value.

- The type of graded sand to be utilized by sieve analysis as one of the components of the STB backfill to obtain tight fit soil.

- The optimum Kaolinitic clay content in the soil to make it less porous and of high specific surface area for optimum moisture retentivity suitable for areas prone to moisture migration on account of low water table.

- The material and composition of thermal backfill will be finalized during detailed Engineering. Bidder shall be responsible for ensuring the best “effective” thermal resistivity.

Subsequent to completion of backfilling, in-situ measurements of soil thermal resistivity, dry cured density, void ratio, moisture and clay contents of the soil shall be carried out by the BIDDER along the cable routes at regular intervals mutually agreeable to the BIDDER and PURCHAER, using his own instruments as a quality check on the backfill employed and method of back-filling and detailed report shall be submitted by BIDDER.

However, the successful bidder shall carry out the required investigation and tests to evaluate and determine the soil resistivity and soil thermal resistivity along the cable route, at cable laying depth, to the satisfaction of the owner.

18.01.7 THERMAL BACKFILLS:

The successful bidder shall design, specify supply formulate, test and lay a suitable backfill, only if the owner desires and with the prior approval of the owner, if found necessary after the receipt of the route survey report for thermal characteristics of the soil.

18.02.0 Laying and installation of Cables:

18.02.1 General

The successful bidder shall carry out all activities connected with the laying and installation of the power cables, and completion of the work for which the project is intended and to the full satisfaction of the owner.

Notwithstanding subsequent changes/alterations in route/design, the bidders shall quote in their bid proposals for carrying out the cable installation work as per the specifications of the owner, which will be considered for bid evaluation.

However, alternate route/installation arrangements offered from the bidders, with clear justification for these alternatives, will be considered by the owner, if they prove to be of a better and economical design and also the quoted bid value is the lowest.

18.02.2 Scope

This scope covers the proposed method of cable laying, in ground i.e., directly buried in ground with laying in ducts, pipes and in air. The excavation and construction of R.C.C., stone masonry, brick masonry ducts, laying of pipes for installing cable and also for the construction of jointing bays as per requirement of the field conditions.

The scope also includes supply of all requisite materials, labour, tools and plant like sand, brick, stones, steel, cement aggregate for reinforcement, pipes, joint and route markers and all other consumables required for the completion of this work.

The bidder shall insure for materials. The bidder shall handle, load, transport, unload and store all materials at site and arrange for security, till commissioning and handing over to the owner.

18.02.3 Drawings

The bidder shall prepare the drawings for the applicable field conditions of cable installation, like cables directly buried, in ducts, in road crossings, on drainage crossings, railway crossings, cable jointing bays, manholes if any, and furnish 6 copies of each to the owner for approval.

All works are to be executed only after due approval of the competent authority and under the supervision of the engineer in-charge.

18.02.4 Specifications

These specifications are intended for general description of quality, of materials and workmanship of finished work.

They are not intended to cover the minute details. The work shall be executed in accordance with the best modern practices, Indian standards (I.S.) and other relevant codes.

The specifications, referred to above are I.S. Standards relevant to Civil Engineering works and cable laying works.

The specifications shall be read in conjunction with the other parts of the bid documents.

The owner's decision shall be final on any issue in respect of installation.

18.02.5 Installation of U.G.Cables

Installation: The cables shall be laid generally in "directly buried in ground/in RCC cable duct in Trefoil touching formation to form 220 KV 3 single core, single circuit system. However, as per requirement of the field, the cables may also have to be laid;

- in ducts/trenches.
- in HDPE pipes in trefoil/horizontal formation (pipes to be filled with sand/suitable material after cabling).
- in Air at terminations.
- At varying depths due to obstructions.
- As per approved drawings.
- In HDPE pipes for railway crossing

18.02.6 Inspection, Storage and Handling

The successful bidder should take all necessary precautions for inspection of cables on receipt, and for the proper handling and storage. The successful bidder shall have his own arrangement for transporting the

cables, materials, equipment to site and back to store.

The cables shall be stored on hard packed surfaces and protected from harmful weather conditions.

The cable drums shall be mounted and transported on only approved type cable drum conveyors. The cable should not be bent beyond permissible limits of the bending radius while laying and jointing.

18.02.7 Statutory Clearances

The installation of cables shall be as per established code of practice and fulfill the requirements of statutes. Obtaining all statutory clearances from other utility services, like telephones, water supply, power supply, Railways, National highways, Bengaluru Mahanagara Palike and other Local Administrative Authorities for road cutting etc., for laying the cable will be responsibility of the successful bidder.

All necessary approvals of the concerned authorities to be obtained before execution of the works by the successful bidder and necessary assistance will be rendered by the owner.

Charges to the civic/national highways/traffic/defence authorities/Railway/ Telephones/Water supply/Power supply/MahanagaraPalike and other Local Administrative authorities etc., as per their standard schedule of rates for grant of permission/approvals for trenching/laying pipes/laying cables etc., are to be paid by the successful bidder. These charges are reimbursable by the owner as per actuals, on production of valid vouchers.

Restoration of the surface to its original condition as per the requirements of the concerned authorities is also included in the scope of the work. (Necessary specification of Bengaluru MahanagaraPalike is included in the Annexure).

The Restoration of the surface shall be carried out as specified in Annexure -1 of the technical specifications (Volume-II) of the tender document.

It is the responsibility of the bidder to ensure the restoration of the surface in complete in all respect before handing over to KPTCL.

18.02.8 Trench/RCC Cable duct

The cable trench/RCC cable duct work involves earth excavation for cable trench/Excavation and Construction of RCC cable duct, back filling and

removal of excess earth from site. The work site shall be left as clean as possible after completion of the work.

The earth for construction of trench/RCC cable duct shall be excavated using manual and mechanical modes as per field conditions. Most of the roads are of asphalt surface and some are with cement concrete surface.

An air compressor with pneumatic drill or equivalent mechanical tool will be essential for the road crossings and railway crossings involve horizontal drilling i.e., Trench-less cutting wherever necessary.

Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly restored.

The sides of the excavated trenches/RCC cable duct shall wherever required, be well shored up with timber and sheeting.

Suitable wooden barriers should be erected between the cable trench and pedestrian / motor way/railway to prevent accidents. The barriers could be made out of Jungle Wood / Deal Wood Planks. These could be portable types of size 1.5M (long) by 1.2M (Height). These barriers should be painted with yellow and black or red and White coloured cross stripes. Warning and caution boards should be conspicuously displayed. Red lights as warning signal should be placed along the trench during the nights and any other requirements as per the traffic authorities directions.

The excavated material shall be properly restored immediately after laying the cable by mechanical compactness to avoid obstruction to public and traffic movement.

The cable shall be laid immediately after formation of trenches. The bottom of the excavated trench should be levelled flat and free from any object, which would damage the cables. Any gradient encountered in trench/cable duct shall be gradual.

18.02.9 <u>Cable Handling</u>

The inspection of cable on receipt, handling of cables, paving out, flaking, cushioning with sand or sieved compacted native soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, preparation of all chambers, sump holes and all necessary precautions that are required shall be carefully planned and in general conform to latest edition IS 1255 - 1983 or its equivalent.

18.02.10 Damage to Property

The successful bidder shall take all precautions during excavation of trench/RCC cable duct trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the owner.

The successful bidder shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

18.02.11 Cable over bridges:

Wherever the cable route crosses the bridges, the cables shall be laid in ducts.

18.02.12 Cable crossing open drains with long span

1) Wherever the cable route has to cross an open drain, with a long span, the cable shall be laid in suitable size ducts, or pipes, suitably jointed with collars. The entire duct system shall be designed as per civil engineering practice and shall be got approved by the concerned authorities and owner.

2) At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes.

18.02.13 Cable route markers / cable joint markers.

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per drawings approved by owner.

Markers provided shall be as per the field requirement. If the route passes through open fields, markers should be conspicuously visible and above ground surface.

The marker should incorporate the relevant information: The name of the owner, voltage, circuit and distance of cable from the marker.

18.02.14 Laying of Power Cables

The 220 KV, single-phase cables shall be laid in Trefoil formation, forming one circuit laid in the trench/duct complying with all applicable standards as per drawings approved by the owner.

The cables shall be laid wherever required in HDPE pipes of ISI approved quality.

When cables are laid in RCC hume pipes, the following points shall be

taken care of.

i. If one cable (single phase) is laid through the Cement Concrete pipe, the CC pipe should not have reinforcement of steel rods.

ii. The cable should occupy only 30-40 % of the area of the cross section of pipe.

iii. The CC pipes shall be backfilled by sand after installing the cable.

iv. The cables shall be protected by covering with a pre-cast RCC slab of approved design and marking throughout the length of the route.

18.02.15 Identification

An identification marker/Tag of lead of size 50 mm x 25 mm x 2mm shall be provided at 2.5 meter intervals throughout the route length of the cable and fastened with a suitable nylon string. The marker shall be embossed/punched on both sides with the letters, KPTCL, 220 KV, CKT-1, Phase identification by coloured PVC tape shall be at 1M interval. Alternatively plastic tags may be used. These tags should also be fixed, at the cable inlet and outlets of a duct, tunnel, manhole and joint bays.

18.02.16 Warning Tape:

A prewarning, Red colour plastic /PVC tape, 150 mm wide 100 microns thick, shall be laid at specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under CAUTION; KPTCL, 225000V CABLES.

18.02.17 Paving out the cable

The excavated cable trench/RCC cable duct shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paving out the cable. The cable shall be rolled in the trench/RCC cable duct on cable rollers, spaced out at uniform intervals. The paving out process must be smooth and steady without subjecting the cable to abnormal tension. For this power winch, power roller – both straight and angle roller, may be used. The cable on being paved out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables shall never be dropped. All snake bends shall be straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension loading shall be by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed not exceeding 600 to 1000 mtrs per hour.

The cable end seals shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores, for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct.

18.02.18 Flaking:

The cables shall be flaked and left with slight extra lengths at jointing bays for expansion and flexibility.

18.02.19 Sand Cushion:

The sieved sand cushion for the cables shall be provided as per the drawings. Sand covering shall be done by hand and in such a manner as to provide complete envelope for the cables and a good bedding for protection covers

18.02.20 Thermal Backfill:

Based on the evaluation of soil thermal resistivity along the cable route and after approval from the owner the successful bidder shall design, specify, supply, lay & monitor the installation of thermal backfill surrounding the cables.

18.02.21 Immediate Envelope To Cable

The option on the use of the material, which immediately envelops the cable viz., thermal backfill or sand or sieved native soil rests with the owner. The successful bidder shall seek prior approval on the use of the envelope material from the owner before execution of the works.

18.02.22 Prevention of damage due to sharp edges

After the cables have been laid in the trench/RCC cable duct and untill the cables are covered with protective covering, no sharp metal tool shall be used in the trench/RCC cable duct or placed in such a position that may fall into the trench/RCC cable duct.

Straight and curved (angle) rollers used shall have no sharp projecting parts liable to damage the cable.

While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct..

The cables shall never be bent, beyond the specified bending radius.

18.02.23 Road Crossings:

The road cutting work for cable trench/RCC cable duct whether cement concrete, asphalt or macadam road surface shall be taken after obtaining approval for cutting from the civic authorities, traffic police, telephone authorities and work should be planned to be completed in the shortest possible time. Whereever necessary the work shall be planned during night time or light traffic periods.

In the excavated trench across the road, the cables shall be laid in HDPE pipes, pipes are embedded in RMC (Ready mixed cement concrete) 1:2:4 proportions, excavation backfilled, compacted and the surface shall be redone in the shortest possible time as per the requirements of the civic authorities.

18.02.24 Footpath Cutting:

The slabs, kerbstones, on the roads shall be removed and reinstated without damage.

18.02.25 Reinstatement:

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energised and taken over by the owner. The protective covers shall then be provided, the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required, then temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

In case of the road surface being cement concrete, asphalt or tarred macadam, resurfacing shall be done as per the requirements of the civic authorities.

18.02.26 Jointing Bays:

The successful bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trial pits. The delivery lengths of the cables shall match the location.

The joint bays shall be of sufficient size to accommodate jointing of cables and constructed with RCC M20 Grade and Fe 415 Steel. It shall consist of RCC raft laid over PCC 1:4:8, RCC Retaining walls/Side walls and RCC cover slab with an inspection chamber. All exposed faces of raft, slab and side walls shall be plastered with 12mm thick Cement Mortar 1:4. At the bottom in a corner, a sump pit shall be made for bailing out water.
After completion of all the works, viz., construction of Jointing Bay, laying of cables, testing of cables/jointing etc., the jointing bay shall be backfilled with riddled sand.

The successful bidder shall submit an economical design and drawing of joint bay for approval of the owner.

All works shall be carried out in presence and supervision of the owner's engineer.

18.02.27 Railway Crossing

The earth shall be excavated using an air compressor with pneumatic drill or equivalent mechanical tool for laying pipes for crossing of railway track after obtaining prior approval of railway authority. The work shall be planned to be completed within shortest possible time. The work shall be carried out as per the standard practice suggested by railway authorities.

18.02.28 Tools and Plant

The successful bidder shall have all necessary tools, plant and equipment to carry out the survey and cable installation work.

The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

18.03.0 JOINTING AND TERMINATING:

18.03.1 Jointing Of Cables

General: The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriageways, driveways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables,

and water mains should be avoided wherever possible.

Sufficient over lap of cables, shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed.
The joints of different phases shall be staggered in the jointing bay.

The cable jointing work should be necessarily got done only through well trained professional jointers.

Jointing work details

i) Uncoiling, cleaning, straightening and trimming of 220KV cable as required for jointing.

ii) Checking the cable inside the joint bay before cutting the cable, for any accidental damages due to re-excavation.

iii) Providing the joint tent, tools etc., at the site by the vendor.

iv) Erection of joint tent, (joint tents should be of metallic housing.

v) Electrification of the joint bay, arranging and fixing of air conditioners and maintaining them for the entire period of jointing (temperature inside the joint tents should be maintained below 25 deg C.)

vi) Transporting the required quantity of jointing kits from stores to site (Including link boxes)

vii) Dismantling the wiring, air conditioner etc.

viii) Dismantling the joint tent.

ix) Devolution of cable cut bits to departmental stores including transportation.

x) Providing security guards for joint bay.

xi) Cost of power for the entire period of jointing.

xii) Providing 2 Nos. 2 HP Diesel Dewatering pumps.

18.03.2 <u>Sumpholes:</u>

While jointing cables in water logged ground or under unforeseen rainy conditions, a sumphole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or bailed out by buckets, without causing interference to the jointing operation.

18.03.3 Tents/Covers

Erection of Joint tent (Joint tent shall be of metallic housing) Electrification of Joint bay, arranging and Fixing of Air conditioners and maintaining them for entire period of jointing (Temperature of Joint tent should be maintained below 25 deg. C)

Providing sheath protection for earthing wherever necessary. All accessories and spares required shall be of satisfactory operation for 10 years and furnish the details of maintenance.

18.03.4 Precautions before making a joint:

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable.

If the cable end seals or cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

18.03.04A PERT CHART

Indicating time schedule for supply of cable and accessories and supervision of cable laying, testing and commissioning shall be furnished by successful vendor in consultation with the purchaser and should be got approved along with drum length approval. The schedule should be kept up by the vendor. Any delay in completing the work will attract penalty.

18.03.5 Measurement of Insulation Resistance:

Before jointing, the insulation resistance of both sections of cables shall be checked.

Before laying cable in the ground, the insulation resistance of each section shall be measured.

18.03.6 Identification:

The identification of each phase shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

18.03.7 Making a Joint

Comprehensive jointing instructions should be obtained from the manufacturer of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity

bonds, lugs, etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

18.03.8 Cable Terminations

The cable terminations used are outdoor type/GIS plugin type.

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures.

The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included.

i) A sufficient length of spare cable shall be left in the ground, for future needs

ii) The rise of the cable, immediately from the ground shall be enclosed in minimum dia of 250 mm HDPE pipe to protect against direct exposure to the sun.

iii) The cable shall be properly fastened using nonmetallic clamps.

iv) Appropriate labels shall be fixed identifying the phase, circuit, Voltage and date of commissioning etc., on the cable supporting structure.

v) The sealing ends shall be mounted on pedestal insulators to isolate them from their supporting steel work.

vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.

vii) Providing earth stations with all required materials like leads, connectors, earthing rods/pipes etc.

ACCESSORIES

Dust and humidity free enclosures complete with air conditioners and material handling equipment shall be used by the vendor.

All special tools including a set of jointers hand tools that are necessary to complete the joint/termination works shall be arranged by the vendor. Necessary power supply for jointing and termination works shall be arranged by the vendor.

The cost of consumables which are essential for satisfactory erection and commissioning shall be included.

Adequate quantity of consumable shall be supplied for completing the entire cable laying and jointing works.

Termination Work details:

1) Erection of termination structure.
2) Removal of cable from the trench, rerouting, cleaning straightening and trimming if necessary, checking the exposed cable before cutting the cable for any accidental damages due to re-excavation.
3) Providing of scaffolding pipes, clamps, wooden planks and tools for erection of termination.
4) Erection of scaffolding pipes/ providing crane for lifting 220KV cable and termination.
5) Lifting the cable up the terminal structure and positioning.
6) Transporting the termination kit from departmental stores (including link boxes)
7) Dismantling scaffolding work.
8) Transporting the above item back.
9) Devolution of cable cut bit to departmental stores including transportation.
10) Provision of security guard for the cable end/ termination.
11) Providing fire retardant paint for exposed portion of the cable and other related works.
12) Cost of power for the entire period of work.

18.03.9 Bonding of screen/sheath

The type of bonding i.e., single end bonding/both end bonding/cross bonding as recommended by the successful bidder, shall be adopted.

For one/both end bonding:

The screens at one/both ends, shall be brought out and solidly bonded/ or through SVL to the earth station through disconnecting type link boxes.

The link boxes, single-phase outdoor type with SVL at receiving end (with bye-pass arrangement for SVL) and without SVL at sending end shall be provided.

All accessories and consumables used in the termination should be of good quality and compatible with the cable.

For cross bonding:

Shall be executed as recommended in Clause No.7.04.03.

18.03.10 Connection of Radial Water Barrier and Cable Screen

If the metallic radial water barrier is insulated from the metallic wire screen a connection suitable to carry the currents occurring during operation must be

installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

18.03.11 Erection of Cable Terminating Structure.

The terminating structure should be designed as per the requirement of the cable end sealing, offered by the bidder.

The mounting structure shall have good cement concrete foundation as per civil engineering norms/Approved drawings.

After fixing the end termination, the cable shall be fixed to the support, with nonmagnetic material clamps to the required height securely. The drawings of station structure and equipment for connection of cable will be furnished by the owner.

18.03.12 Surplus Cable

The wastage of cable beyond practically required permissible limits should be avoided.

For any valid reason if there is a surplus cable, it shall be returned to the owner's store.

Approved good quality sealing caps, heat shrinkable type of the correct size, shall be supplied for spare cut lengths of cable exceeding 100 M length, to enable them to be properly stored for future maintenance purposes. The successful bidder shall be responsible for the immediate sealing of such cut lengths and the cost of the sealing end etc., thereof shall be deemed to have been included in the contract price.

The successful bidder shall clean the completed cable route and shall remove all surplus and waste materials, empty cable reels etc., preferably the same day but not later than the next day after the particular work is completed.

18.04.0 CIVIL AND STRUCTURAL WORKS:

General : This specification deals in brief with the civil and structural works for cable laying.

a) The scope of civil works include earth excavation for cable trench & RCC cable duct and cable laying, removal of excavated earth, design, supply and provide plain & reinforced cement concrete for foundations of equipment, support structures, back filling, dewatering of trenches. Design, supply and providing cable jointing bays. The design of RCC cable duct for laying the cable along the route and cable duct/pipe ducts for crossing drains, roads, railway lines etc., shall be suitably done and rates quoted, making provision for complete supplies and erection as per relevant schedules. It includes all connected civil works.

b) Design, fabrication and supply of galvanised steel structures for cable end terminations, mounting of earthing link boxes.

c) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

18.04.1 Codes And Standards

Unless otherwise stated, latest Editions of the following standards are applicable.

IS:1255	:	Installation and Maintenance of Power Cable.
IS:5820	:	Specification for pre-cast concrete cable cover.
IS:209	:	Quality of Zinc for galvanising.
IS:226	:	Structural Steel.

IS:456	:	Plain and Reinforced Cement Concrete.
IS:800	:	Use of structural steel in general building construction.
IS:2016	:	Plain washers.
IS:2633	:	Zinc coating on Galvanised Steel.
IS:3063	:	Spring washers.
IS:5358	:	Hot Dip Galvanised coating on fasteners.
IS:6639	:	Hexagonal Bolts for steel structures.

Any other equivalent International/National Standard.

18.04.2 Excavation

The specification covers excavation for cable trenches, ducts, structural foundations, jointing bays.

The successful bidder shall control the grading in the vicinity of all excavations so that the surface of the ground will be properly sloped or diked to prevent surface water from running into the excavated area during construction.

The excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance to permit the placing,

inspection and setting of forms and completion of all works for which the excavation is done.

The sides and bottoms of excavation shall be cut sharp and true. Under cutting shall not be permitted. Earth sides of excavation shall not be used in lieu of form work for placement of concrete unless authorised by the Engineers of the owner where the limitations of space for large excavation necessitates such decision.

18.04.3 Quantities

The bidder shall indicate the ceiling volumes/quantities for excavation and RCC works and Steel structure works, wherever specifically indicated.

18.04.4 The bidder shall quote unit rates for the items of works. He shall also quote the total price for each of the works.

18.04.5 The quoted price shall also include supply of all material, transportation charges, taxes, duties, octroi and toll, labour, construction plant and equipment and fixtures, fittings and all temporary and permanent works

necessary for satisfactory completion in all respects.

18.04.6 The measurements of various civil works shall be jointly recorded; by the successful bidder and the Engineer-in-charge of the owner and duly certified.

18.04.7 When machines are used for excavation the last 300mm. before reaching the required level shall be excavated by hand or by such equipment that will leave the soil at required final level in its natural condition.

18.04.8 The bottom of the excavation shall be trimmed to the required level and when carried below such level by error, shall be brought to level, by filling with lean concrete of 1:4:8 mix, at successful bidder cost.

18.04.9 If the successful bidder is directed by the Engineer-in-charge of the owner to excavate to a lower level than that indicated on the drawing, such additional excavation shall be paid for at the applicable unit rates provided in the tender. The rates shall be firm irrespective of increase in quantities to any extent. The bidder is bound to carryout any Non-tendered items of work required for completion of the task. For such items of work the applicable KPWD /MWSR schedule of rates, Data rates or derived rates whichever found appropriate will be allowed.

18.04.10 The successful bidder shall be responsible for his estimates, assumptions and conclusions regarding the nature of the materials to be excavated and difficulty of making and maintaining of required excavations and performing the work required as shown on the drawing and in accordance with these specifications. Cofferdams, sheeting, shoring, bracing, draining, dewatering etc., shall be furnished and installed as required and the cost thereof shall be included in unit rate quoted for the item of excavation. The successful bidder shall be held responsible for any damage to any part of the work and property caused by collapse of sides of excavation. The materials can be salvaged if it can be done with safety for the work and structure and as approved by the Engineering-in-charge.
However, no extra claim shall be entertained for material not salvaged or any other damage to successful bidder property as the results of the collapse. He shall not be entitled to any claim for redoing the excavation as a result of the same.

18.04.11 All excavation for installation of underground facilities shall be open cuts.

18.04.12 The excavation for foundation where specified shall be carried out atleast 75mm. or as specified in relevant drawing below the bottom of the structure concrete and then be brought to the required level by placing lean concrete of 1:4:8 Mix or as specified with aggregate of 40mm. nominal size.

18.04.13 When the excavation requires bracing, sheeting, shoring, or strutting etc., the successful bidder shall submit to the Engineer-in-charge drawings

showing arrangement and details of proposed installation and shall obtain the approval from the Engineer-in-charge before proceeding with the work.

18.04.14 The successful bidder shall have to constantly pump out the water collected in the pits, trenches, due to rain, sub-soil, springs etc., and maintain dry working conditions at no extra cost to the owner.

18.04.15 Classification of soil:

For purpose of excavation, the soil is classified as ordinary soil, Hard soil, Ordinary rock and Hard Rock. The details of classifications are given in Annexure - TS-I.

18.04.16 Measurement Of Excavation:

The measurement, for the payment of earth excavation will be based on volume calculations of pit/trench. The unit of measurement shall be cubic meters. Nothing extra would be payable for slopes, shoring, strutting, etc., irrespective of whatever is provided. If directed by the Engineer-in-charge, the excavation shall be done on the slopes from slope stability point of view at no extra cost to the owner.

18.04.17 Carriage of excavated soil beyond a lead of 50 mts per lift of 1.5 mts.

18.04.18 By manual labour:

The excavated earth for disposal purpose beyond 50 mts and upto 300 mts shall be carried by manual labour. If directed by the Engineer-in-charge, this earth shall be used for back filling purpose. The rate for disposal of earth by manual labor upto 300 Mtrs shall be included in the excavation item and no extra rate for the same is admissible.

18.04.19 By Mechanical Transport: The successful bidder shall arrange to transport the surplus earth and soft/hard rock, left over after back filling the trench up to the required level (with watering and compaction) and disposal of earth by manual labor, by Mechanical means, to the disposal point of the local bodies with all leads and lifts and as directed by the Engineer-in-charge. It shall however be ensured that no soil is stacked in excavated area. Location where the soil is to be stacked/disposed shall be as directed by the Engineer-in-charge. However the successful bidder shall take all precautions at the site of excavation, for keeping the free flow of vehicular and human traffic and to avoid inconvenience in general.

The soil transported for disposal, shall be stacked and leveled neatly and dressed.

The rate for this item shall include loading, carriage, unloading, stacking and dressing etc., complete.

18.04.20 In no case the excavated soil shall be stacked upto to the distance of 1.5 mts from the edge of excavation or one third the depth of excavation whichever is more.

18.04.21 Lead And Lift:

The rates quoted for all items of work shall include all lifts and leads whenever applicable unless otherwise specified.

18.04.22 Excavation and measurement in Hard Rock:

Blasting in hard rock shall be done as per IS: 4081 (latest Edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Premeasurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

At locations where, open blasting can not be taken up due to site conditions, controlled blasting or removal of rock by chiseling & wedging shall be resorted to. The rate for excavation of hard rock shall include its removal by all the types referred to, appropriate to the site conditions.

18.04.23 Backfilling Materials:

The backfilling of excavated trenches/RCC cable duct & around foundation shall consist of one of the following materials as the Engineer-in-charge may direct in each location.

i) Selected sieved earth from excavated soil.

ii) Selected sieved earth brought from borrowed area.

iii) Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.

Filling shall be done after the concrete or masonry work has fully set and its curing completed.

The successful bidder shall fill in and around any work untill it has been properly reinstated and approved by the Engineer-in-charge.

18.04.24 Backfilling for cable trench:

Backfilling shall be done in horizontal layers of thickness not exceeding 300mm thickness, free from pockets with careful watering where necessary for compaction. The backfill shall be riddled earth free from materials likely to cause damage to the cables.

The thermal backfill surrounding the cable shall be as per the design approved, by the owner.

18.04.25 Measurements:

Payments for back filling shall be based on the volume of consolidated fill. This volume shall be derived from the difference between the volume of excavation and that of the structure (Concrete work, sand filling), or trench as the case may be.

18.04.26 Specification For Cement Concrete:

For the cement concrete, plain or reinforced for general use, requirement of concrete for nominal mix, strength and quality, pouring at all levels, form works, protection covering, finishing, add mixtures, inserts, curing etc., the provisions of the latest revision of IS:456 shall be complied with, unless permitted otherwise by any other Indian Standard Codes, shall form the part of the specification to the extent applicable within specification. The cement used shall comply with IS:269. The metal (Jelly) used in PCC/RCC shall be properly graded and machine mixed.

18.04.27 Curing And Protection Of Concrete:

All fresh concrete shall be covered with the layer of an absorbent material and kept constantly wet for a period of seven days or more from the date of placing concrete. The immature concrete shall be protected from the damages and contamination, that would impair the strength of the concrete.

18.04.28 Precast RCC Items:

The concrete mix for the various types of precast units shall conform to IS:456. The aggregate shall be mixed by weight and water cement ratio shall be controlled to obtain the dense concrete and the strength required. The reinforcement shall be as per the design approved. The curing shall be carried out for the period of seven days from the date of casting, and the precast element shall be cured by flooding with water of minimum 25mm. depth over the element for the period mentioned above.

All the precast element shall be marked, appropriately as specified.

18.04.29 Masonry Work:

Stone masonry and Brick (Table mould) masonry work wherever required shall be carried out by the contractor. The associated materials for masonry work like stones, bricks, sand etc., shall be of approved quality. The construction shall comply with accepted norms and standards.

18.04.30 Plaster: Plastering shall be done with cement and sand mortar, 1:4 by volume with clean sand. All plaster work shall comply with IS:1661.

Materials for plaster such as cement, sand, water shall conform to standards.

18.04.31 Mounting Structures:

The mounting structure include the supports for cable end boxes, link boxes and any other structure required for the intent of the contract.

All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust etc., that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the owner. The structures shall be fabricated by the contractor.

18.04.32 Foundation:

Foundations for mounting structures in cement concrete shall be provided as per approved drawings by the Engineer-in-charge.

18.04.33 Bolts Nuts and Washers:

Standard bolts, nuts and washers shall be used in all works. These should be galvanised in accordance with IS:5358.

18.04.34 Painting:

Outdoor Kiosk for link boxes etc., shall be painted with anticorrosive paint and red oxide as primer and two coats of enamel paint. the boxes should be appropriately labelled as per installation at site regarding the Sl. No. location, type caution board/Danger Board. etc.

18.04.35 Materials Used In Cable Laying:

Specification in brief on the materials used in installation of the 220 kV underground cables, like RCC precast cable protection covers, precluded cement concrete blocks for cable route/joint indication, cable and

mounting structures, joint bays, earthing and other miscellaneous materials are given below. All materials shall conform to relevant standards, and shall be approved by the Engineer.

18.04.36 RCC Precast Cable Protection Covers:

These should be pre casted as per the approved design and drawing. The reinforced cement concrete should be M20 grade (1:1.5:3 proportion) with 20 mm. and down size coarse aggregate and steel reinforcement (Fe 415 grade) shall be used and cured as per civil Engineering Standards. The covers should carry the legends KPTCL 220 kV CABLES, CKT-1. The covers should be free from burrs and projecting edges so that they may be easily laid to butt. The average breaking load shall be 450 kgs for the cover slabs.

18.04.37 Cable Route Markers/Joint Markers:

Permanent and durable type, cable route markers/ joint indicating blocks should be provided as per the design supplied by the owner.

The cement concrete block should be made by the wet process and the concrete shall consists of one part cement two parts sand four parts aggregate of size 20mm. and down.

The marking block should be given a smooth cover surface of cement mortar and shall have the appropriate legends, 5mm. deep engraved on them as “KPTCL 220 KV CABLE CKT-1”, “KPTCL 220 KV CABLE JOINT CKT-1”.

18.04.38 Pipes:

HDPE pipes of ISI Mark, 250mm dia and above, 20 mm thickness approximate, of good quality shall be used for formation of cable ducts. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided.

Hume pipes and accessories conforming to IS shall be used if required. Reinforced hume pipe shall not be used for laying single core power cable, in one cable per pipe arrangement.

Stoneware pipes, salt glazed of good and approved quality shall be used.

Hume pipes without steel reinforcement, stoneware pipes, HDPE pipes can also be used where the cable passes through the passage or drive ways of public and private buildings.

In case of pipe – the size of the pipe shall be at least 30 to 40% more than size of cable. The pipe joint shall be done by using proper sleeves so as

to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable.

18.04.39 <u>Supporting Structure For Cable And Cable End Terminations</u>:

The bidder shall quote for unit prices for support structure for each single core cable to suit the end termination supplied by him. The bidder shall design and furnish the details and drawings.

These support structures shall be fabricated out of galvanised steel pipe to IS:1239 or they shall be fabricated out of galvanised mild steel sections, such as channels, I-beams etc., conforming to IS:226, pipes if used for fabrication of the structure shall not have any joints.

The height of the structure shall be such that the terminal connection to receive the owner's ACSR Double Drake/Moose conductor/63 mm. Diameter, IPS aluminium pipe is approximately at a height of 4.5 meters. The successful bidder shall be furnished with relevant drawings by the owner.

18.04.40 The supporting structure shall be suitable to withstand, the wind pressure, seismic forces and the short circuit forces, etc., and the design shall be with an adequate factor of safety as specified in I.E. rules 1956.

18.04.41 The bidder shall furnish the design and fabrication drawings, foundations, foundation anchor bolts, design calculations etc., of these structures.

18.04.42 <u>Terminal Connectors</u>:

The terminal connector/clamps shall be suitable for connection to 63-mm diameter IPS aluminium pipe or double Drake/Moose ACSR conductor. The terminal connector shall be of bimetallic type to connect the terminal of the cable end to the aluminium bus pipe or ACSR conductor.

The type and size of the connector will be confirmed to the successful

bidder. The connector/clamp shall be designed to overcome:

i) Galvanic Corrosion.

ii) Thermal Cycling.

The current carrying capacity of the connector/clamps shall be greater than the maximum capacity of the power cable.

The terminal clamp shall be free from burrs, voids and blowholes.

The terminal clamps shall have passed tests for short circuit current capability and temperature rise.

18.04.43 Sand:

Sand supplied for backfill shall be river sand, free from flakes, dust, earth, organic matter and large pebbles and stones and should be free from any chemical contaminants likely to have corrosive action on the cable coverings.

The sand should be sieved through a mesh to remove all large stones and pebbles. The sand shall be properly graded and shall conform to IS:383 for concreting work.

The owner will decide on the requirement of the use of sand depending on the availability of the excavated earth to be used for backfill.

The sand should be used with the approval of the owner as a backfill.

18.04.44 Earthing:

The earthing system required is for the

i) Earthing of all non-current carrying metal parts and

ii) Earthing system for cable screens/sheath bonding at terminations and at all others places wherever required.

The latest editions of the following standards and codes are applicable.

i)	IS:3043	:	Code of practice for earthing.
ii)	IS:2309	:	Code of practice for the protection of building and allied structures against lightning.
iii)	Indian Electricity Rules 1956	:	Provision of Rules on EHV systems.
iv)	IEEE-80	:	Guide for safety in sub-station grounding.

All equipment, supporting and mounting structures of the installation shall be bonded together and connected by separate and distinct conductor to earth electrode.

18.04.45 Earth conductor:

The earth conductor shall be of GI flat, of size 50 x 6 mm. size and shall be protected against mechanical damage and corrosion. The connection of the earth continuity conductors to earth bus and earth electrodes shall be strong, secure and sound and shall be easily accessible.

18.04.46 Pipe Earth Stations:

The pipe earth electrodes shall be of cast iron in conformity with IS:3043, buried vertically and the pit filled with alternate layers of charcoal, salt and earth. The earth lead shall be properly fastened with brass bolts nuts and connection shall be enclosed in a masonry chamber. The chamber shall be provided with a RCC inspection cover.

18.04.47 The connection between the earthing terminal of equipment and earth electrode shall be made by short and direct earthing lead, free from kinks and splices.

18.04.48 The distance between any two electrodes shall not be less than, twice the length of the electrode.

18.04.49 All joints shall be covered with suitable compound to protect against corrosion.

18.04.50 Earthing connections with equipment earthing terminals shall be of bolted type. The contact surfaces shall be free from scale, paint, enamels, grease, rust or dirt. Two bolts shall be provided for making each connection. The bolted connections after being checked and tested shall be painted with anticorrosive paint or compound.

18.04.51 Welds and brazed joints shall be treated with red lead and afterwards coated with bitumen compound to prevent corrosion.

18.04.52 Steel to copper connection shall be brazed type and shall be treated to prevent moisture ingress.

18.04.53 The resistance of the welded joint shall not be more than the resistance of equivalent length of the conductor.

18.04.54 All welded joints shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature.

18.04.55 Arc welding with large diameter conductor shall be done with low hydrogen content electrodes.

18.04.56 Bonding Of Cable Screens/Sheath:

Each single-phase cable shall have a separate earth for the screen earthing.

The system short circuit level is 50 kA for 1 Sec. The earthing lead at solid earth positions shall be single core, 400 sq.mm copper conductor, PVC insulated 6.6 KV voltage grade Cable.

18.04.57 **Earth Tests**:

Tests on earths shall be carried out by the successful bidder for testing the effectiveness of earth resistance of electrodes and the results furnished to the owner.

19.00.0 TESTING COMMISSIONING, TYPE/ROUTINE TESTS ON CABLES AND ACCESSORIES

19.01.0 General

The material and equipment covered under this contract are subject to strict codes of owner approved Q.A.P., inspection, and tests.

19.01.1 The Engineer or his authorized representative shall have, at all reasonable times access to the contractor's premises to inspect and examine the materials during manufacturer and if part of the equipment is being manufactured or assembled on other premises or works, the bidder shall arrange and obtain permission for the purchaser as if the equipment/material is manufactured at the bidder's own premises. The Owner can depute upto Five Engineers from KPTCL for inspecting the equipments/materials. The Visa to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the contractor.

19.01.2 The inspection requirement for material shall conform to the design, assembly fabrication and tests defined in the reference code of standards.

19.01.3 Approval or passing of any such inspection by the owner, shall not however, prejudice the right of the owner to reject the material or equipment, if it does not comply with the specification when installed and or fails to give the intended service.

19.02.0 Notice of Inspection:

19.02.1 The successful bidder shall give the owner thirty days written notice of any material being ready for inspection and tests.

19.02.2 The Engineer shall, within fifteen days of the inspection, give notice in writing to the successful bidder of any defects noticed during inspection. The successful bidder shall take corrective measures and shall confirm in writing, of the compliance or otherwise, with due reason.

19.02.3 The Engineer shall issue a certificate for having inspected the material/equipment within thirty days of inspection. The issue of the certificates does not bind the owner to accept the material should it on further tests on installation be found not to comply with the contract specification.

19.02.4 In the case of stage inspection, the successful bidder shall proceed from one stage to another only after the component is inspected by the owner and permission given to proceed further. The same procedure shall apply for any rectification or repairs suggested by the owner.

19.02.5 The owner or the Engineer, shall have the right to inspect any machinery,

material, structure, equipment, plant or workmanship, furnished or used by the contractor, and may reject any or all which is defective or unsuitable for the use and purpose intended, or which is not in accordance with the specification.

The successful bidder on demand by the owner shall remedy or replace, at his expense, such defective material/plant equipment. In the event of the failure by the successful bidder for correcting the defect or replacement of the material / equipment plant, the owner may take such remedial measures necessary, at the expense of the contractor.

19.02.6 On the material to be supplied under this contract, it is to be noted that it shall not relieve the successful bidder of his responsibility for supplying material conforming to requirement of the contract, nor prejudice any claim right or privilege which the owner may have because of the use of defective material.

Should the owner waive the inspection, any item of the material, such waiver shall not relive the successful bidder in any way from his obligation under the contract.

In the event of inspection by the engineer, and the inspection revealing

goods/materials not in conformity with the standard/specification, the owner shall specify additional tests/inspection procedures, if required, to ascertain compliance with specifications.

19.02.7 A set of latest relevant approved drawings/data /applicable Reference Standards shall be made available to the Engineer during inspection.

19.03.0 TEST ON MATERIALS SUPPLIED BY SUB-SUCCESSFUL BIDDER:

The plant or equipment supplied by the sub-successful bidder of the successful bidder shall comply in every respect to the specification and applicable tests.

19.04.0 TEST MATERIAL:

The successful bidder shall provide test pieces, as required, in quantity, to determine the quality of material supplied under this contract. If any test piece fails to comply with the requirement the Engineer may reject the whole material represented by the test pieces.

19.05.00 TESTS AT MANUFACTURER'S WORKS:

19.05.01 The test at works shall include the electrical, mechanical and hydraulic and other special tests in accordance with the relevant standards.

A complete test schedule/programme shall be furnished by the contractor.

The successful bidder shall carry out all the tests as specified by the owner, under tests for relevant material.

19.05.2 Test certificate include, test records and performance graphs, drawings, which shall be supplied to the owner. All tests shall be carried out in accordance with the provisions of the contract.

All test certificates must be endorsed with sufficient information to identify the material or equipment to which the certificate refers, and must carry in the top right hand corner the identification of the owner and the contract.

20kV DC voltage test between the metallic sheath and the outer sheath for each and every length of the cable delivered should be conducted and the sheath leakage at 10kV, 15kV and 20kV are to be furnished and got approved before dispatch of cable drums. The leakage current shall be within limits of 5.0mA for 500mtrs at 20kV Dc and 2.0mA for 500mtrs at 10kV DC.

19.05.3 The routine, acceptance and type tests conducted in the presence of the Engineer, and the test certificates shall be approved before the materials are dispatched.

19.06.0 MANUALS & LITERATURE ON MATERIAL/EQUIPMENT

The bidder shall enclose with his offer all literature and manuals relevant to the contract and in particular

i) On cable offered.

ii) On cable jointing and terminating techniques.

iii) Instructions on cable installation, storage, handling, maintenance, fault finding, repairs, preventive maintenance etc.

iv) Literature on special Tools & plant.

v) Literature on sheath bonding, maintenance of link boxes.

vi) Any other relevant literature/manual

19.07.0 TESTS:

19.07.1 The successful bidder shall make available to the Engineer a complete set of detailed data, required for inspection and tests.

19.07.2 Routine & acceptance Tests shall be conducted at the factory by the successful bidder in accordance with the relevant standard code to determine the performance and characteristics of material equipment/ accessory and to determine whether or not the guarantees of quality have been met.

19.07.3 Routine & acceptance Tests shall be conducted in accordance with the relevant IEC-62067: 2011

19.07.4 TYPE TESTS:

The Successful bidder shall indicate that the equipment/material offered has successfully passed the type tests as required by the relevant standard.

Relevant type test certificates shall be furnished along with the bids to prove the quality of the material/equipment including those of the accessories.

The successful bidder shall agree to conduct all tests or repeat the tests already conducted, for the satisfaction of the owner.

19.08.0 ELECTRICAL TESTS AFTER INSTALLATION:

19.08.1 The Successful bidder shall conduct the following tests during and after installation as per IEC 62067: 2011.

19.08.2 In the event of the installation failing the tests, the successful bidder shall at his own expense, identify the cause and rectify the defects, and render the installation serviceable.

19.08.3 **DC Voltage Tests of the Over sheath**:

a) After the cables have been laid and the trench partly filled and before joints are made a 20KV DC voltage is applied to the over sheath of cable, between the metallic sheath and earth for 15 minutes.

b) The test should be repeated when all the accessories have been installed, before commissioning.

c) The above tests shall be carried out by the vendor in the presence of owners' representative.

d) Should a breakdown of the sheath occur during these tests, the vendor shall locate the fault and repair the cable(s) after owner's agreement until the retests give satisfactory results for the total link.

e) All expenses in connection with the civil works which are made necessary for faults location and repair shall be borne by the vendor including additional costs for the services rendered by the owner

19.08.4 A.C. TESTING:

The installation shall be tested with AC voltage.

(A voltage equal to 1.7 U_0 or 180Kv applied for One hour between each conductor and metallic sheath as per Cl. No. 16.3 of IEC-62067: 2011, where U_0 is the RMS rated voltage between the conductor and the earth or the metallic sheath. The waveform shall be sinusoidal and the frequency shall be as per Cl. No. 16.3 of IEC-62067.

The installation shall withstand for One hour with the phase to phase voltage applied between the conductor and metallic screen/sheath

OR

Test for 24 hours with the normal operative voltage of the system.

19.08.5 TEST ON NON METALLIC SHEATH:

The non-metallic sheath shall be subjected to test as per IEC publication 60229.

19.08.6 The bidder can recommend any other test, for satisfactory performance of the installed system.

19.08.7 PRE- COMMISSIONING – ELECTRICAL TESTS AFTER INSTALLATION:

On completion of cable laying, jointing and termination works the complete installation will be tested with.

DC Voltage test on over sheath as above for complete installation.

Sheath fault occurring during laying, testing after laying and during pre-commissioning should be rectified by the vendor free of cost (including civil

works) Necessary sheath repairing kits with heat shrinkable materials are to be supplied as per the site requirement during execution of works.

The following pre-commissioning tests shall be carried out by the VENDOR after installation.

1. Electrostatic capacitance of the cable
2. Resistance of the cable conductor.
3. Resistance of the Sheath.

These tests should be got done by CPRI.

The vendor is requested to quote testing charges.

The owner reserves the right to witness all the tests and the vendor shall provide all facilities to the owner in this regard. The date of testing will be informed by the owner sufficiently in advance to the vendor's supervising engineer, to enable the vendor to carry out the tests.

The vendor should furnish (5 copies) of the test results for calculating the total losses.

The observation period shall be one month of operation after energizing of the cable. For this period of one month the cable circuits will be operated by KPTCL under normal conditions.

If a breakdown occur on the cables or accessories during this period, all

repairs shall be made by the vendor at his own expenses including civil works and road cut restoration charges. Owner reserves the right to request to change the full length of cable between the two joints chambers, free of charge including duties and taxes etc., this shall not apply for injuries of external origin.

After the verification is done, field tests shall be carried out again according to site tests specified in the tender clause.

The observation period shall be 3 months of operation after repairs and re-energisation. No breakdown shall occur. If breakdown occurs again on the cable & accessories during this period, all repairs & replacement shall be made by the vendor as given in the above para. When the observation period is completed, the guarantee period will start.

20.00.0 DOCUMENTATION

The following documents should be furnished

a) Along with the bid:

1) Dimensioned cross sectional details of the cable.
2) Current carrying capacities “with supporting calculated data” of the cable and derating factors.
3) Manual of instructions on cable handling and cable laying.
4) Type, acceptance and routine test certificate on the cables as per relevant IS, IEC or other national standards to be furnished by the bidder. For accessories test certificates shall be furnished along with the bid.
5) GA drawing of Dimensioned cross sectional details of the straight through joint kit furnished along with the bill of material.
6) Detailed drawing of the straight through joints to be furnished by the bidder.
7) Type, acceptance and routine test certificate on the straight through joints shall be furnished by the bidder.
8) OGA drawing of the cable end termination furnished along with the offer.
9) Dimensioned cross sectional details of cable end termination with bill of materials to be furnished by the bidder.
10) Manual of instructions on the method and formation of the cable end termination to be furnished by successful bidder.
11) Type, acceptance and routine test certificate on the cable end termination to be furnished by the bidder.
12) OGA drawing of the cable termination structure along with the bill of materials-to be furnished by the bidder.
13) Foundation drawing of the cable terminating structure.
14) Civil Engineering details of jointing bays with cross sectional elevation and plan.

15) Dimensioned cross sectional details and plan of cable trench/duct/road crossing /drain crossing showing the position of cable.

16) Dimensioned cross sectional drawing of the pipe electrode earthing along with bill of materials.

17) Drawing showing the method of bonding of the cable screen/sheath and the earth connection to be furnished by successful bidder.

18) Drawing of RCC cable protection cover.

19) Calculation of induced voltages in the sheath and the recommended method of bonding.

20) The Successful bidder shall submit 10 sets of cable installation records giving all the details sought by the owner along with the routes map.

b) On award of the contract:

1) The successful bidder shall prepare all relevant and associated drawings of the route layout plan indicating the road crossing, crossing across drains, nallahs, railway lines etc., and location of the straight through joints.

2) The owner will communicate approval to the drawings furnished in respect of the supply as well as for the installation portion within one month from the date of submission.

ANNEXURE - TS 1

CLASSIFICATION OF SOIL STRATA

1.0 Ordinary Soil:

This shall comprise of vegetable or organic soil, turf, sand, sandy soil, silt, loam, clay, mud, red earth, suade, peat, black cotton soil, soft shale, loose murrum, mud debris, concrete below ground level, a mixture of all these and similar material which yields to the ordinary diggingimplement. Removal of gravel or any other modular material having diameter in any one direction not exceeding 75 mm, such occurring strata shall be deemed to be covered under this category.

2.0 Hard soil

This shall include :

(1) Stiff heavy clay, hard shaleor compact murrum requiring digging tool or pick or both and shovel closely applied.

(2) Gravel, soft laterite, kankar and cobble stone having maximum diameter in any one direction between 75 mm and 300 mm.

(3) Soling of road paths, etc., and hard core.

(4) Macadam surfaces such as water bound and bitumen/tar bound.

(5) Lime concrete, stone masonry in lime/cement mortar below ground level.

(6) Soft conglomerate, where the stones may be detached from the matrix with picks.

(7) Generally any material which requires the close application ofpicks or sacrifices to loosen and not affording resistance to digging greater than hardest of any soil mentioned in item (1) to (6) above.

3.0 Ordinary Rock :

(1) Ordinary rocks comprising of limestone, sand stone, hard laterite, fissured rock, conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars.

(2) Unreinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level.

(3) Boulders, which do not require blasting having maximum diameter in any

direction of more than 300 mm found lying loose on the surface or embedded in river bed, soil, talus slope wash and terrace material of dissimilar origin.

NOTE: Hard laterite does not require blasting. It is to be classified under ordinary rock which does not require blasting.

4.0 Hard Rock :

This shall comprise :

Any rock or cement concrete or RCC for the excavation for which the use of mechanical plant or blasting is required.

Hard rock shall be removed by blasting where the same is permitted/allowed. In restricted places hard rock shall be removed by chiseling and wedging/ controlled blasting without causing inconvenience to the free flow of vehicular and human traffic and also without endangering the human life, property etc.

SECTION – DRS

DATA REQUIREMENT SHEETS

(TECHNICAL DATA SHEETS/GUARANTEED TECHNICAL PARTICULARS)

NOTE: Please furnish Technical Data Sheets duly filled in, with each set of Technical bid.

Design, Manufacturer, Testing at works, supply, Civil Engineering works, installation, testing, commissioning of 127/220 kV Single Core, 2500 Sq.mm XLPE underground cable and accessories.

CONTENTS

Sl.No.	DESCRIPTION	ANNEXURE
1	Schedule of Guaranteed Technical Particulars of Cable.	Annexure-I
2	Schedule of Guaranteed Technical Particulars of Accessories (Outdoor type termination).	Annexure-II
3	Schedule of Guaranteed Technical Particulars of Normal Straight Joint.	Annexure-III
4	Schedule of Cable Covering Protection units/surge voltage limiters & link box.	Annexure-IV
5	Schedule of Drawings/Graphs	Annexure-V

ANNEXURE-I

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF CABLE

The bidder shall furnish the following information, in addition to any other relevant data, for laying conditions specified, for 127/220 kV E 2500 Sq.mm, Copper, Single Core, XLPE insulated, lead sheathed Cable. The Technical parameters shall be supported with the calculations data sheets.

1	Name of Manufacturer	
2	Country of Manufacturer	
3	Type of Cable/Cable Code	
4	Applicable standard	
5	Voltage a) Rated Nominal Voltage b) Rated Maximum Voltage	
6	Continuous current carrying capacity in Amps (Calculation to be shown separately)	
7	Permissible voltage & frequency variation for satisfactory operation	
8	Suitability for a) Earthed System b) Unearthed system	
9	Type of process of manufacturing of cable (a) Triple Extrusion (Yes/No) (b) Whether VCV method (Yes/No)	
10	Conductor – Construction details a) Nominal Cross section (Sq.mm) b) Material c) Shape d) Diameter of Conductor (mm) e) Number of wires per conductor (Nos.) f) Nominal diameter of wire in conductor (mm)	
11	Conductor screen a) Material and type (extruded) b) Thickness (mm) c) Maximum volume resistivity at 90 $\pm$ 2^0C before and after ageing (ohm-cm)	
12	Maximum value of Electric stress at a) Conductor screen kV/mm b) At the insulation kV/mm	

	(Calculation to be shown separately)	
13	Insulation XLPE a) Curing process (furnish details separately. b) Material/Composition c) Dia over insulation d) Radial thickness i. Nominal (mm) ii. Average (mm) iii. Minimum (mm) iv. tmax-tmin/tmax≤ 0.1 e) Specified insulation resistance at 90^0C f) Insulation resistance at 20^0C	
14	Insulation screen (Non metallic) a) Material & type (extruded) b) Nominal thickness (mm) c) Maximum volume resistivity at 90± 2^0C (ohm-cm) d) Maximum dielectric stress (calculation to be provided)	
15	Tape Swellable (Longitudinal Water/Moisture Protection) a) Material b) Thickness c) Tolerance	
16	Radial Water Barrier (lead sheath) a) Type/Composition b) Material c) Nominal Thickness d) Tolerance on Thickness e) Diameter of cable over metallic sheath (mm)	
17	Bedding Tape Over Inner Sheath i) Material ii) Dimension (Wxt) (mm) x (mm) Nom. Min.	
18	Concentric Screen/Armour of Stainless steel/Bronze/Plain Copper Wires a) Material b) Diameter Nom. (mm) Min. (mm)	

	c) Whether screen is to be earthed at both terminations (Yes/No) d) Screen Voltage/KM corresponding to rated current of cable with one end of screen unearthed (Volts). e) Screen current corresponding to rated current of cable with both ends of screen earthed (Amps) f) Screen Loss/KM corresponding to rated current of cable with both ends of screen earthed (Watts) g) Screen voltage/KM corresponding to short circuit current in cable for 3 phase fault with one end of screen unearthed (Volts) h) Screen current corresponding to short circuit current in cable for 3 phase fault with both ends of screen earthed (Amps) i) Current rating of screen under short circuit duty (Amps) j) Separation between armour wires (mm) k) Direction of lay l) Thickness of tape (mm)	
19	Binder Open Helix, Contact Copper Tape Over Screen/Armour Wires a) Material b) Dimension (Width x thickness) Nom. (mm) Min. (mm)	
20	Non-woven Water Swellable Tape Over Binder Tape a) Material b) Dimension	
21	Overall Sheath i) Material & Type ii) Thickness Nom. (mm) Min. (mm)	
22	Conductive Coating on Outer Sheath a) Material b) Thickness	
23	Anti-termite treatment to outer sheath a) Material	
24	External Overall diameter of	

	Cable	
25	Weight of cable/mtr(Kgs)	
26	Short Circuit rating of conductor 90^0C Operating Temperature for 1 Sec.	
27	a) Minimum Cable Bending Radius (in terms of Cable Diameter) b) Recommended minimum installation radius	
28	Permissible Maximum Tension	
29	Continuous Current Rating Under specified Installation Conditions at Conductor Temperature of 65^0C & 90^0C Ground Temperature 30^0C Thermal resistivity of soil 120-150^0C CM/W Depth of laying 1500 mm Ambient Air Temperature 50^0C No. of Circuits 1 Formation Trefoil touching	Details to be furnished as per the table given below for thermal resistivity of soil of both 120^0C Cm/watt and 150^0C Cm/watt

TABLE

	Single Point/Cross Bonded		Both End Bonded	
	65 deg. C Amps	90 deg. C Amps	65 deg. C Amps	90 deg. C Amps
Current Rating conductor size 2500 sq.mm.				
a) In Ground/Trench				
b) In RCC Duct				
In HDPE (250 mm dia) pipe, i) one cable per pipe ii) Three cable per pipe				
c) In air				

30	Maximum Permissible Conductor Temperature for continuous operation under specified installation conditions (^{0}C)	
31	Conductor temperature at rated current (^{0}C)	
32	Temperature rise for 20% over current	
33	Emergency overload rating	
34	a) Basic impulse level at conductor temperature of 90^{0}C (kV) b) Impulse wave shape	
35	Ionisation factor at 50 Hz	
36	Power frequency withstand voltage (kV)	
37	Tan Delta at 50 Hz (at U_o kV and 90 (-5/+10)^{0}C	
38	Sheath voltage at max. load in Amps: single point bonded, Trefoil touching formation (V/KM)	
39	Withstand voltage of sheath on spark test	
40	Permissible short circuit current ratings of conductor i) 0.1 Sec KA	

	ii) 0.2 Sec KA **iii) 0.5 Sec KA** **iv) 1.0 Sec KA**	
41	**Short circuit capacity of conductor for one second at 90^{0}C prior to short circuit and 250^{0}C during short circuit (KA)**	
42	**Maximum conductor resistance DC & AC** **a) at 20^{0}C (d.c)/A.C. ohm/KM** **b) at 90^{0}C (d.c)/A.C. ohm/KM** **c) at 105^{0}C (d.c)/A.C. ohm/KM (over load temp) a.c. (ohm)** d) at rated continuous current in ground as per Cl. No. 4.00.00 B(i) 10(ii) of Techncial specification (dc)/AC ohm/Km	
43	**Equivalent star resistance at 50 Hz of 3 phase current** **a) at 20^{0}C ohm/KM** **b) at 90^{0}C ohm/KM** **c) at 10% continuous over load temperature (ohm/KM)**	
44	**Star reactance at 50 Hz (ohm/KM)**	
45	**Approximate impedance at 50 Hz per KM** **a) at 20^{0}C ohm/KM** **b) at 90^{0}C ohm/KM** **c) at 10% continuous over load temperature (ohm/KM)**	

46	**Self electrostatic capacitance per phase (Micro farad/KM)**	
47	**Maximum Power factor at Charging KVA of cables when laid direct in ground at normal voltage & frequency** **a) at ambient Temperature** **b) at Maximum Conductor Temperature**	

48	a) Positive and Negative sequence Impedance (Ohm/Km) b) Zero Sequence Impedance (Ohm/KM)	
49	Zero Sequence Data a) Series Resistance (ohm/Km) b) Series Reactance (Ohm/Km) c) Shunt Capacitive Reactance (Ohm/Km)	
50	a) Sheath Resistance at 20^0C Ohm/Km b) Screen Resistance at 20^0C Ohm/Km c) Combined Resistance at 20^0C Ohm/Km	
51	Sheath voltage under maximum operating conditions, assuming all circuits connected KV per KM	
52	Potential gradient at conductor surface KV/Cm - Maximum - Minimum	
53	Surge Impedance of Cable (ohm/km)	
54	IR value at ambient Temperature per Km	
55	Maximum magnitude of partial discharge at 1.5 Uo. At Ambient Temperature (Pc) At High Temperature (PC)	
56	Guaranteed losses per Km (Calculation sheet to be furnished) For details such as current rating, AC resistance to be considered etc., Refer Guaranteed losses clause no.10.09 of technical specification & respective clause of SCC of bid documnts	
	a) Dielectric Loss per phase at rated voltage and rated current b) Copper Loss per phase at rated voltage and rated current. c) Sheath / screen loss per phase at rated voltage & rated current. d) Other losses due to reinforcement e) Total Losses at rated continuous current	
57	Charging Current at rated Voltage per Km	

	(Amps)	
58	**Circulating Currents Under BEB Condition in Lead** **i. Sheath Amps:** **ii. Copper Wire Screen Amps:** **iii. In Both Amps:** **When current in conductor is 950A**	
59	**Circulating current in lead sheath armouring / Cu screen (when the conductor is carrying 50 KA S.C. Current) KA**	
60	**Combined Short Circuit Capacity of Metallic Sheath and Screen for 1 Sec, at metallic sheath / screen temperature of 75^0C (conductor temperature 90^0C before S.C. & 250^0C during S.C) KA**	
61	**Screening factor of cable for calculating interference on control and communication cables:**	
62	**Approximate Value of attenuation of carrier current signals operating over a frequency range** **i. 50 KC/s - dB/KM** **ii. 100 KC/s - dB/KM** **iii. 150 KC/s - dB/KM** **iv. 200 KC/s - dB/KM**	
63	**Shipping Weight and size of cable drum.** **a) Size of Drum** **i. Dia of Drum(M)** **ii. Width of Drum(M)** **iii. Gross Weight(Kgs)** **iv. Length of Cable Per drum(M)** **v. Weight of Cable(Kg/M)** **Weight of copper (Main conductor excluding copper wire screen) (Kg/M)** **Weight of copper (Copper wire screen excluding main main conductor(Kg/M)** **viii. Weight of lead(Kg/M)**	
64	**Guaranteed maximum life in years**	

TABLE - II

65. DERATING FACTORS

a) VARIATION IN GROUND TEMPERATURE:

Ground Temperature	**:**	**15**	**20**	**25**	**30**	**35**	**40**	**45**
Rating Factor	**:**							

b) VARIATION IN DEPTH OF LAYING:

Depth of Laying (Meters)	**:0.7**	**0.9**	**1.0**	**1.2**	**1.3**	**1.35**	**1.5**	**1.8**
Rating Factor	**:**							

c) VARIATION IN THERMAL RESISTIVITY OF SOIL:

Thermal Resistivity of Soil:	**100**	**120**	**150**	**200**	**250**
(^{0}C cm/watt)					
Rating Factor	**:**				

d) VARIATION IN AIR TEMPERATURE:

Air Temperature (^{0}C)	**:**	**25**	**30**	**35**	**40**	**45**	**50**	**55**
Rating Factor	**:**							

e) VARIATION DISTANCE (mm):

Axial Distance (mm) Between Circuits	**:**	**100**	**200**	**300**	**400**	**600**	**800**
Rating Factor	**:**						

ANNEXURE-II

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR ACCESSORIES

Outdoor Type Cable end Termination (Sealing End)/ Plugin type for GIS Modules

1.	**Manufacturer's Name**	**:**
2.	**Country of Manufacture**	**:**
3.	**Class and Type**	**:**
4.	**No. of years the design in commercial use**	**:**
5.	**Rated Voltage Kv**	**:**
6.	**Rated Continuous Current Amps**	**:**
7.	**Size of sealing end termination**	**:**
8.	**Total Creepage Distance (mm)**	**:**
9.	**Maximum Conductor Size, Cu (Sq.mm)**	**:**
10.	**Details of Terminal Connector**	**:**
11.	**Power Frequency Voltage 1 Min Dry withstand : Test kV. rms**	
12.	**Power Frequency Voltage Wet withstand Voltage kV Time: Sec.**	**:**
13.	**Power Frequency Voltage Dry withstand Voltage kV. rms**	**:**
14.	**Flashover voltage Dry KV rms Wet KV rms**	**:**
15.	**Radio Interference Voltage (R.I.V.) Test (Micro Volts)**	**:**
16.	**Partial Discharge (corona) extinction Test**	**:**
	a) Extinction Voltage kV rms	**:**

b) Minimum Detector Sensitivity PC :

17. Impulse Voltage Lightning Voltage Dry Withstand kV (Crest) :

18. Direct Voltage 15 Min Dry withstand kV :

19. Description of Materials Used in the terminations with electrical & mechanical Particulars :

20. Mounting Structure Details for termination :

21. Electrical & Mechanical Particulars of

a) Heat Shrinkable Tubing :
b) Heat Shrinkable Moulded Parts :
c) Heat Shrinkable adhesives/sealents :

22. Type Tested to [Standard (s)] :

23. Other Details :

Please Enclose complete Technical literature :

ANNEXURE-III

Normal Straight Joint (Earthing Type) And (Straight Joint Insulated)

1.	Name of Manufacturer		:
2.	Country of Manufacture		:
3.	Type (Design) of Joint		:
4.	No. of years the design is in commercial use		:
5.	Rated Voltage	kV	:
6.	Rated Current	Amps	:
7.	Suitable for cable Conductor	Sq.mm	:
8.	Connector, Type, Material		:
9.	Partial discharge test 245 kV	PC	:
10.	A.C. Withstand Voltage	kV	:
11.	Impulse withstand voltage +ve& -ve 10 times kV		:
12.	Load Cycling 90^0C + 5^0C (No. of Cycles)		:
13.	Load Cycling as above under Water at -----KV	(No. of Cycles)	:
14.	D.C. Withstand ----- kV	Hrs	:
15.	D.C. Withstand Voltage 15 Min		:
16.	Conductor thermal short circuit 250^0C For 1 Sec		:
17.	Shield thermal short circuit 250^0C for 1 Sec		:
18.	Type Tested to Standard (S)		:
19.	Maximum conductor temperature in joint at rated current.		
20.	Additional Information		:

ANNEXURE-IV

I. Cable Covering Protection Units / Surge Voltage Limiters:

1. **Manufacturer's Name :**
2. **Country of manufacture :**
3. **Type of Material :**
4. **Dimensions / Weight mm/Kg :**
5. **Rated Voltage Kv :**
6. **Characteristics :**
7. **Nominal discharge current KA :**
8. **Power frequency withstand voltage KV :**
9. **Power frequency spark over voltage kV :**
10. **Reseal voltage :**
11. **Pressure relief class :**
12. **Impulse high current short duration Discharge (Amps) :**
13. **Additional Requirements :**

II. Link box details and other accessories:

Sl. No.	Technical Particulars	
1. a)	Details of Link Box Material.	
b)	Type of Application	
c)	Drawings	
d)	Accessibility	
e)	Suitability	
f)	At Circuit end	
g)	Option	
h)	Special arrangement	
i)	Accessories	
2.	Cross-bonding Link Box (CBB) Concentric bonding leads of suitable size to suit 3 Nos of Co-axial cable entries to CBB	
3.	Sheath Bonding Cables	
4.	Cross Bonding of Cable Sheath	
5.	No Of Joints	

6.	**Sheath standing voltage to earth for rated cable current**	
7.	**Sheath standing voltage to earth when an external 13-symmetrical through fault**	
8.	**Transposition of cables: No. of Cable Transpositions and other details.**	
9.	**Details of Distributedc Temperature Sensing (DTS) system such as make, No. of Channels, Distance covered, components of Hardware, List of Softwares, Industrial PC, DTS Cofigurator, Protocol adopted, applicable standards etc.**	

III. List of consumables to be supplied by the vendor

Sl. No.	Description	Quantity

ANNEXURE – V

SCHEDULE OF DRAWINGS/GRAPHS

The bidder shall furnish the following drawings along with the graph.

Sl. No.	Description	
1	Cross section and dimensional drawings of the cable with weight	
2	Detailed drawings of the straight through joint.	
3	Detailed drawings of the direct earthing link boxes. a) Weather proof type b) Structure mounted type	
4	Detailed drawings of sheath earthing link boxes weather proof type	
5	Detailed drawing of the cable earthing arrangement	
6	Detailed drawing of the cable protection unit (S.V.L)	
7	Outline dimensional and assembly drawings of cable sealing end.	
8	Outline dimensional and assembly drawings of a) Normal straight joint	
9	Detailed drawings of cable termination supporting structure and foundation.	
10	Schematic drawings of cables installation Cable screen earthed at both ends. Installation of cables in trench(direct buried) Installation of cables in RCC ducts Installation of cables in RCC through/over open drains Installation of cables in pipes Plan and cross sectional drawings of cable jointing bay in detail, with transposition of cable with cross bonding of cables. Plan and cross sectional drawings of cable jointing bay in detail, without transposition of cable with cross bonding of cables.	
11	Detailed drawing of RCC cable protection Covers.	
12	Detailed drawing of cable reel/drum.	
13	Characteristics of cable temperature Vs current	
14	Characteristics of cable and sealing end-power factor Vs temperature.	
15	Characteristics of cable and sealing end-power factor Vs voltage.	
16	Characteristics of cable and sealing end-partial discharge magnitude v/s temperature.	

17	**Characteristics of cable covering protection unit (S.V.L)**	
18	**Foundation drawing of Cable end termination structure Special link box mounting structure**	
19	**Arrangement of joint chamber with dimensions**	
20	**Arrangement of terminal structure for outdoor sealing end with civil designs with earthing arrangement cable**	
21	**Cross section of sheath bonding cable**	
22	**Drawing of straight rollers and angle rollers**	
23	**Trefoil clamp**	

ANNEXURE-VI

Schedule of instruction manuals/catalogues/calculations/certificates etc.

Sl. No.	Description	Quantity
1	Description of extrusion, curing and cooling processes	
2	Transport, storage and handling practices for cables and accessories	
3	Electrical characteristics (conductor resistance, capacitance, electrical stress etc.) of the cables	
4	Characteristics of sheath voltage limiters and surge arresters	
5	Manning schedule for one set of three straight through joints and one set of three sealing ends	
6	Design calculations – wherever called for against respective clause of specification and GTP	
7	Type test certificates issued by a recognised institution	

NOTE: Not exhaustive. Bidders may furnish additional documents as required.

ANNEXURE-VII

1) Schedule of tests and charges for tests

Sl. No.	DETAILS OF TEST	CHARGES PER TEST
I-A	Type Tests	
B	Routine Test	
C	Site Tests	
D	Special Tests (Specified)	
E	Other tests at works/Site Recommended by the tenderer	
II	Total cost towards inspections and tests (special routine and acceptance tests) included in the price bid (if chargeable to owner) (break-up details to be furnished separately)	
	Note: Details have to be furnished for tests on cables as well as accessories, each separately.	

ANNEXURE-VIII

Test Data on the 220 KV XLPE cable and accessories

Sl. No.	DETAILS REQUIRED		STANDARDS AS PER WHICH TESTED	DATA/TEST RESULTS TO BE FURNISHED
1	**FOR IMPULSE TEST (HOT CONDITIONS):**			
	i.	Number of samples tested		
	ii.	Cable cross section and insulation wall thickness		
	iii.	Type of terminations		
	iv.	Type of joints		
	v.	Basic impulse level (wave form and peak voltage)		
	vi.	Breakdown level		
2	**FOR POWER FREQUENCY TEST (COLD/HOT CONDITIONS):**			
	i.	Number of samples tested		
	ii.	Cable cross section and insulation wall thickness		
	iii.	Type of terminations		
	iv.	Type of joints		
	v.	Voltage applied and duration		
	vi.	Breakdown level		
3	**FOR LONG TERM TESTS:**			
	i.	Length of the cable loop		
	ii.	Cable cross section and insulation wall thickness		
	iii.	Number and type of terminations & joints		
	iv.	Installation conditions (air, buried)		
	v.	Voltage applied and duration		
	vi.	Conductor temperature at the end of heating cycle		
	vii.	Breakdown conditions (if any)		

NOTE: Details should be furnished for each and every sample for item (1) and (2) and for each and every long term test for item (3).

ANNEXURE-IX

SCHEDULE OF DOMESTIC VALUE ADDED COMPONENTS

Sl. No.	ITEM	QUANTITY (EX-WORKS)	UNIT PRICE (EX-WORKS)	TOTAL PRICE
	Total Ex-works bid price (X)			

Total Ex-works bid price (X) =

Domestic value added component =

Domestic value added component =

(as percentage of total Ex-works bid price)

*** To be furnished for each category separately**

SECTION – DRS

DATA REQUIREMENT SHEETS

ANNEXURE TS-II

Turnkey Package for supply, installation of 220 KV cables with all associated accessories and materials at various locations in Bangalore City.

List of drawings enclosed with the Bid Document

S.No.	Description	Drawing No.
1	Proposed Cable Route	Uploaded in the Website
2	Single Line Diagram	Uploaded in the Website
3	Sheath Bonding System	
4	Cable Construction	
5	Cable Trench	
6	Cable Trench for Road Crossing	
7	Cable Duct	
8	Precast RCC Tile	
9	Reinforcement Details of Precast RCC tile	
10	Cable Route/Joint Marker	
11	Pipe Earthing	

ANNEXURE-I

PROCEDURE AND SPECIFICATION TO BE FOLLOWED BY UTILITY AGENCIES

FOR RESTORATION OF FOOTPATH

1 Removing footpath slabs if any and stacking at a designated place with all lead and lifts of 50 mtrs. and Earth work excavation for leveling and lowering the footpath to the required depth and slope, as directed. Removal of roots and other organic materials including consolidation with watering to get the required density to the satisfaction of BMP Engineer incharge of work.

2 Providing polythene sheet of 300 micron thick over the prepared surface adequately stiffened to prevent distortion during handling in order to prevent the slurry entering the sub soil.

3 Refixing the stone slabs longitudinally at the outer edge with a projection of 2.00 cms. above the concrete surface and cutting the edges to regular shape and with pointing in CM 1:3.

4 Removing and refixing in position available Kerb stones of granite, dressing the top surface and neatly rounding of the edges and fixing in ground with excavation to the required depth in all soils and pointing in CM:1:3 and providing painting to kerb stones with Black and yellow Japan paint alternatively and as directed by BMP Engineer incharge of work.

5 Providing and fixing precast fiber reinforced semicircular shoulder drains of 0.60 m. dia in CC M20 grade with necessary earth work at an interval of 30mtrs. or less as per site conditions including fixing, laying, curing, with all lead and lifts etc., complete as per the direction of Engineer incharge and providing and fixing recast RCC covering slab of 100 mm thick over shoulder drain flushing with concrete surface.

6 Formation of footpath surface to a width of 0.450mtr. at an interval of 30mtrs. and covered with precast covering slab of 10 cms thick in blend with RMC concrete to facilitate drawing of underground cable whenever necessary.

7 Providing necessary catch drain in front of shoulder drains, of size 0.23 x 0.60 x 0.40 mtr. clear with necessary grating over catch drain with one end of the grating fixed with hinges for easy operation.

8 Providing CI/ precast grating at the mouth of the shoulder drain and suitably and firmly fixed with the kerb.

9 Supplying and fixing necessary edge stones or suitable protective measures

around to the existing trees/poles etc.

10 Providing and laying 100mm thick ready mixed cement concrete M25 over the prepared surface covered with polythin sheet using 20mm and down size granite jelly with necessary form work including vibrating groom finishing and curing etc., with all lead and lifts etc., complete to a width of 2 mtrs with proper expansion joints at an interval of 6 mtrs etc., complete as per drawing.

11 Restoration of road cross cuttings to be done by refilling the excavated trench with available soil in layers of 15 cms. With watering and compacting, over which to be filled with good quality of sand to a minimum depth of 0.30 mtr and the top surface to be provided with 20 Cm thick ready mixed cement concrete (RMC) of M25 grade to the full width of the trench, including vibrating, compacting, curing etc., complete with all leads and lifts and in level with the existing road surface.

12 Providing mountable kerb to the approaches wherever necessary with necessary pointing and painting.

13 Conveying the surplus earth, debris or any other unwanted loose materials at the works spot to the designated dumping yard with all leads and lift as directed by BMP, Engineer incharge of the work.

GUARANTEED LOSSES:

i) The bidder shall clearly indicate the guaranteed value of the losses (at a maximum of two decimal places only) which **shall be firm and without any tolerance limit** in respect of under mentioned types of losses, as required in Schedule-14 at rated current, voltage & frequency **per circuit KM (all 3 phases put together in one KM length of cable) in KW only**.

(a) Dielectric losses
(b) Conductor/Copper losses.
(c) Sheath losses.

ii) The Guaranteed values of these losses quoted by the bidder will be taken for capitalizing the losses at the rates indicated below wherein the quoted prices shall be loaded by the differential capitalized loss amount for the purpose of bid comparison. For fraction of a KW quoted, capitalized cost of losses shall be calculated on pro-rata basis.

1	Capitalized Cost of Dielectric Losses	**Rs.4,53,000/- per KW.**
2	Capitalized Cost for Conductor/Copper loss and sheath loss.	**Rs.1,85,000/- per KW.**

iii) For the purpose of evaluation of the offer, the lowest individual losses/CKM quoted for each type of losses by any bidder shall be taken as the basis to work out the deviation in quoted losses by any particular bidder. No rounding-off of any value will be done and Loss values will be reckoned up to TWO decimal places only. The bid price would then be enhanced by the differential capitalized amount for the purpose of comparison of bids.

iv) The cable losses guaranteed in the bid are to be supported by design calculations along with documentary evidences if any, as per procedure & formula stipulated in IEC 60287-1-1 with latest amendments thereof. The reference of the same along with an extract of applicable IEC Standard shall be clearly furnished along with the GTP.

v) The value of loss factor of the XLPE insulation (tan δ) shall be as per IEC 60287-1-1 i.e., 0.001. This value shall be taken for calculation of dielectric losses/evaluation. No upper tolerance limit would be allowed for this value. However bidder can supply cables of tan delta values lesser than 0.001

vi) The current in the conductor (I), for computation of conductor/copper loss shall be the rated continuous current in ground, as per clause no. 4.00.00 BI (11) (ii) of Technical specification of cable. The AC resistance of conductor (R_{ac}), at the **said rated continuous current in ground** shall be considered for calculation of copper losses. All cable parameters considered for loss calculation shall be as per the values declared by the bidder in the GTP. Any assumptions/ Omissions in the Formula used for detailed loss calculation as per the above IEC shall be invariably indicated in the GTP.

vii) In case the declared guaranteed/quoted losses are in deviation to the losses arrived as per calculation, the higher of the two would be considered for evaluation of the offer and the lower of the losses would be considered for acceptance of the cable.

viii) On testing, if it is found that actual losses are more than the values guaranteed/quoted in Schedule-14, penalty shall be recovered from the bidder at the rates ***triple the capitalisation cost*** indicated under sl. no. (ii) above. However, no incentive would be allowed if the actual losses are found to be less than the guaranteed/quoted values.

ix) The cable would be accepted only if the measured values/test values/actual values on the finished product (on testing) is found to be within +5% of the guaranteed/quoted values for each type of losses subject to recovery of penalty as stated in sl. no (viii) above. In case the measured value is exceeding the limit of 5% in any type of these losses, the cable would be out rightly rejected.

x) The guaranteed values of the losses quoted by the successful bidder will be verified at the time of final acceptance of the material after conducting necessary Tests on a random sample/s of the material taken from the finished product. The Tests shall be conducted in the laboratories as per terms and conditions as noted elsewhere in the tender documents.

TECHNICAL SPECIFICATIONS FOR SUPPLY, LAYING, TESTING & COMMISSIONING OF 2000 Sq.mm., 220KV XLPE INSULATED UNDERGROUND CABLE AND ACCESSORIES

1.00.0 SCOPE:

1.01.0 This specification provides for the establishment of an underground cable transmission scheme on total turnkey basis which includes the design, manufacture, inspection and testing before despatch, packing and delivery F.O.R. (destination) of 220KV, 2000 Sq.mm, Single Core XLPE Insulated lead sheathed cable and accessories under the supply portion and laying, including obtaining permission for road cutting from Bruhath Bengaluru Mahanagara Palike (BBMP), Local Administrative Authorities and other agencies for execution of work, handling and installation of materials required in laying, site testing and commissioning under the erection portion.

1.01.1 SITE:

The site is located in Karnataka State, India.
Route: Please refer the enclosed drawing for the tentative route plan of the cable.

1.02.0 SCOPE OF WORKS

The scope of work includes:

1.02.1 Surveying of the proposed cable route including digging and closing of trial pits, preparation of requisite drawings and finalizing the cable route in consultation with the owner's representative.

NOTE: In the expected cable route, ground structure may change from one point to another, and in some places like Railway Crossing , Major Road Crossing, the local environment is especially bad which may lead to unexpected accelerated ageing of insulation and would limit the life expectancy of the cable itself. The successful bidder has to execute works by taking all the necessary precautions so as to get 1250 **Amps** of current flow in the cable per circuit (Refer clause No. 4.00 (B)(i)(10)(i) & (ii)).

Even after considering all the derating factors for laying cable in those locations, the minimum continuous current shall be 1250 **Amps** per circuit.

1.02.2 Testing and evaluation of the soil resistivity, soil thermal resistivity, pH value, of the soil along the cable route, and based on the data, recommend the final system design.

a) Perform a through route soil thermal resistivity survey by in-situ testing along the entire cable route.

b) Conduct a detailed analysis of soils / strata encountered along the route for the thermal performance under specified cable loading.

c) Specify a suitable thermal backfill so that the soil thermal resistivity does not exceed 120^0C cm/watt, to encapsulate the cables to prevent thermal run away of cable.

d) Design of optimum cable trench including RCC ducts and optimum backfill dimension.

e) Formulation of thermal backfill, quality control and supervision during backfill.

f) Obtaining Road cutting permission from Bruhath Bangalore Mahanagara Palike (BBMP), Local Administrative Authorities and any other permissions from other utilities.

1.02.3 Design the method of installation of U.G. Cables, cable laying, excavation and back-filling of cable trench, supply and installation of associated materials like sand, bricks, warning tape, protective slabs, pipes, ducts, civil works etc.

1.02.4 Design, manufacture, testing at works / test house, supply, storage, installation, testing and commissioning of 220 kV cables with all associated materials and accessories.

1.02.5 Design, supply erection, testing and commissioning of

a) Surge Voltage limiters

b) Grounding Switches.

c) Link boxes with Links and with/without SVL

1.02.6 Design for the installation, supply of materials and construction of cable ducts, supports for cable crossings of storm water/sewerage drains wherever required. Design, supply of materials and laying of pipes/construction of cable ducts for railway crossing and road crossing wherever required.

1.02.7 Supply, installation, testing and commissioning of

a) Normal straight through joints for Normal bonding/ Cross bonding of cables.

b) Outdoor cable terminations.

1.02.8 Design, supply and erection of structures for mounting / supporting cable with terminations.

1.02.9 Supply of recommended essential spare parts.

1.02.10 Supply of tools and tackles.

1.02.11 Furnishing all relevant drawings, data and instruction manuals.

1.02.12 Supply of all consumable items, like cable end sealing caps for cable during transport and jointing and all others associated sundry materials.

1.03.0 SCOPE OF SERVICES:

1.03.1 The Scope of the services includes supply, installation, laying erection and commissioning of the cable system on total turnkey basis. The scope shall include but not limited to the following.

1.03.2 Complete checking, monitoring, storing of the materials at the site, and co-ordination of work. Transporting of materials from site stores to site and returning unused material to KPTCL stores.

1.03.3 Finalize procedure of installation and erection in consultation with owner.

1.03.4 Regular supervision and following up of erection / installation work

1.03.5 Testing and commissioning the system / equipments for successful commercial operation.

1.04.0 The cables and its accessories shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer / erection and the owner shall have the power to reject any work or material, which in owner's judgement is not in full accordance therewith.

1.05.0 All the volumes of this bid documents along with amendments thereof be read and interpreted together. However, in case of a contradiction between the "Technical Specification (Vol. II)" (i.e., this volume) and any other volume, the provisions of this volume will prevail.

1.06.0 It is not intent to specify completely all the details of Design and construction of cable and accessories. However, the cable and accessories shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing continuous commercial operation up to the suppliers guarantee period in a manner acceptable to the Owner who will interpret the meanings of drawings and specifications and shall have power to reject any work or material, which in Owner judgment, is not in accordance therewith. The cable offered shall be complete with all the components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of the bidder irrespective of whether they are specifically brought out in this specification and/or in the commercial document or not.

NOTE:

1. The scope shall cover supply of all required equipments, accessories, spares and jointing kits and tools and plant, competent supervision and consumables. All other matching materials required (whether specifically mentioned or not) for complete installation, testing and commissioning of the system shall also be covered.

2. After completion of laying and back filling the road shall be restored as per specification of BBMP and applicable local Authorities. Specification of the same is enclosed.

1.07.0 QUANTITIES:

The quantities, length of cable, number of accessories and other materials indicated in the bid proposals are solely for the purpose of bid evaluation. The successful bidder after detailed route survey shall estimate the actual quantities and take up manufacture and procurement action for materials after approval of the Owner.

2.00.0 STANDARDS:

2.01.0 The construction of the cable shall generally conform to IS 7098 (Part-3) and IEC 62067 with exception to the specific requirements of these specifications and tests as per **IEC-62067**. Except to the extent mentioned in the specification, the cables and the accessories shall conform to the latest editions and amendments of the standards listed hereunder wherever applicable.

IEC-60050	Electro Technical vocabulary.
IEC-60060	High Voltage Test Techniques.
IEC-60093	Recommended tests for volume and resistivity of electrical insulating materials.
IEEE-48	Test procedures and requirement for AC cable terminations 2.5 to 765kV
IEC-60122	Recommended method for determining the comparative tracking index of solid insulating materials under moist condition.
IEC-60183	Guide to selection of high voltage cables.
IEC-60216	Guide for the determination of thermal endurance properties of electrical insulating materials.

IEC-60228	Conductors of insulated cables.
IEC-60228-A	(First supplement) Guide to the dimensional limits of circular conductors.
IEC-60229	Test on cable over sheaths which have a special protective function and are applied by extrusion.
IEC-60230	Impulse test on cables and their accessories.
IEC-60243	Recommended method of tests for electrical strength of solid insulating materials.
IEC-60250	Recommended method for determination of permittivity, dielectric dissipation factor of electrical insulation materials at power, audio frequencies.
IEC-60270	Partial Discharge measurements
IEC-60287	Calculation of continuous current rating of cables, 100% load factor.
IEC-60540	Test methods for insulation and sheaths of electric cables and cores.
IEC-60811	Common test methods for insulating and sheathing materials of electric cables. (Applicable parts / sections of different editions)
IEC-60840	***Applicable clauses only*** Power cable with extruded insulation for voltages above 30kV (U_m=36kV) up to 150 (U_m=170Kv). Test methods & requirements.
IEC-60853	Calculation of cyclic & emergency current rating of the cable.
IEC-60885-2	Electrical test methods for electric cables, part-2: Partial discharge tests.
IEC-60885-3	Electrical test methods for electric cables part-3 Test methods for partial discharge measurement on lengths of extruded power cables.
IEC-62067	Power cable with extruded insulation and their

	accessories for rated voltage above 150 kV – Test Methods & requirements.
IEC-60949	Calculation of thermally permissible short circuit currents, taking into account non-adiabatic heating effects.
IS-3043	Code of practice for earthing
IS-1255	Code of practice for laying of power cables.
IS-1885	Electro Technical vocabulary applicable parts.
IS-5216	Guide for safety procedures and practices in electrical works
IS-5831	PVC insulation and sheath of electric cables.
IS 7098 (Part 3)-93	Cross-linked polyethylene insulated, thermoplastic sheathed cables 66kV to 220kV.
IS-8130	Conductors for insulated cables and flexible cords.
IS-10810	Method of test for cables: Applicable parts.
IEC-62271-209	Cable Connection for gas insulated metal enclosed switch gear for rated voltage above 52kV.
Indian Electricity Act - 2003	Indian Electricity Rules, 1956 (Or its Latest Amendments).

NOTE: i) For the purpose of this specification all technical terms used hereinafter shall have the meaning as per relevant IEC/IS specification.

2.02.0 The Standards mentioned above are available from:

Standard	Name & Address
IS	Bureau of Indian Standards, ManakBhavan, 9, BahadurshahZafarMarg, New Delhi – 110 001, INDIA.
IEC	International Electro-Technical Commission, Bureau Central De 1a commission, Electro Technique Internationale, 3, Rue De Verembe,P.O. Box 131 CH-1211Geneva,20–Switzerland.

2.03.0 Cables/Cable accessories satisfying the quality requirements of other National/International standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the bidder conforms to other standards, salient points of difference between the standards preferred and the specified standards shall be clearly brought out in the offer. Four (4) copies of the reference standards in English language shall be furnished along with the offer.

3.00.0 SYSTEM DATA:

a) Rated voltage:

The cable defined in this specification have the following rated voltage:

Uo/U (Um) = 127/220 (245) kV

"Uo" is the r.m.s. rated voltage at power frequency, between the conductor and the earth or the metallic sheath:

Uo = 127 kV

U is the r.m.s. rated voltage at power frequency, between two phase conductors:

U = 220 kV

"Um" is the maximum r.m.s. voltage at power frequency, between two conductors for which the cable and its accessories are to be designed:

Um = 245 kV

b) Operating Conditions:

1.	Nominal rated voltage (KV rms)	–	220 KV
2.	Highest system voltage (kV rms)	–	245 KV
3.	Number of phases	–	3
4.	System frequency (Hz)	–	50 ± 3%
5	Impulse withstand voltage 1.2/50 micro seconds wave of positive/negative polarity (kVp)	–	1050
6.	Power frequency withstand voltage (kV rms)	–	460

7.	System earthing	–	Effectively Earthed (Solidly grounded)
8.	Maximum fault level & its duration	–	50KA for 1 Sec
9.	Dynamic withstand capability	–	125 KA
10.	Total Relay & Breaker operating time (Milli seconds)	–	90-120

4.00.0 A. CLIMATIC CONDITIONS:

1.	Ambient air temperature	–	Min 5^0C
		–	Max 50^0C
2.	Average daily ambient air temperature	–	30^0C
3.	Relative humidity	–	10–100%
4.	Ground temperature at a depth of 1500 mm	–	30^0C
5.	Altitude above Mean Sea Level (M)	–	1000
6.	Average Rainfall (mm)/annum	–	1000
7.	Ceraunic level (days/year)	–	40–50
8.	Seismic level (horizontal acceleration)	–	0.3 g

B. OPERATING CONDITIONS:

i. CABLES:

1. Method of installation – Directly buried in ground/RCC cable duct

2.	No. of Circuit	–	Single
3.	Depth of laying (average)	–	1500 mm from the center of cable arrangement
4.	Soil Condition	–	Dry Heterogeneous garden Soil
5.	Thermal Resistivity of soil (assumed) Deg. C-cm/watt	–	120 to 150

Bidder shall furnish the current rating of 2000 Sq.mm cable at Thermal resistivity of soil at 120^0C-Cm/watt and 150^0C-Cm/watt. However the successful bidder has to measure the soil thermal resistivity along the cable route and the cable has to be designed suitably.

6.	Formation	–	Horizontal

7. Spacing between two circuits (if applicable)	–	800 mm (for 2 Circuits)	
8. Sheath Bonding	–	Cross bonding.	

Bidder shall recommend the type of bonding to be adopted with detailed calculation of sheath voltage, sheath current and current rating.

9. No. of cores	–	Single	
10. Conductor size	–	2000	Sq.mm
11. Rated continuous current (minimum)			
i. In Air	–	1450	Amps.
ii. In ground	–	1250 Amps. (after considering all derating factors)	
12. Conductor material	–	Enameled Copper	

ii. TERMINATIONS:

1) Installation		–	Outdoor type/GIS module Plugin Type in conformity with IEC 62271-209.
2) Atmosphere		–	Polluted.
3) Switchgear		–	SF6 Circuit breaker (AIS/GIS)
4) Clearance (air)	ph-ph	–	3650 mm
at 220kV (phase voltage)	ph-earth	–	3350 mm

5.00.0 TECHNICAL PARAMETERS OF CABLE:

TYPE OF CABLE:

127/220 kV single core, stranded, annealed, copper conductor, segmental compacted, circular (Miliken), XLPE insulated, lead sheath, copper wire screen, High Density Polyethylene outer sheathed cable (please see details under construction of cable).

The tests shall be as per IEC-62067 with latest amendments.

Voltage grade – 127/220 (kV rms)

Max. operating conductor temperature	–	90^0C
Max. conductor temperature under short Circuit for 1 sec.	–	250^0C

5.01.0 CONSTRUCTION OF THE CABLE:

Construction : 127/220 kV (Earthed), single core 2000 Sq.mm stranded, annealed, copper conductor, segmental, compacted, circular (Milliken), conductor screen, cross linked polyethyline (XLPE) insulation, core screen, semi-conducting water swellable layer, lead alloy 'E' sheathed, semi-conducting bedding tapes, helically applied plain round copper wire screen, plain copper tape in open helix, water swellable tape with overall extruded High Density Polythylene sheath coated with graphite.

Conductor : Plain, annealed, high conductivity copper wires stranded, segmental conductor (Milliken).

Conductor screen : Extruded semi-conducting layer.

Insulation : Dry cured cross linked polyethyline.

Nominal thickness 25.00 mm (min)

In any particular point, the thickness may differ from the nominal thickness, however, the measured thickness shall stay within the following limits.

Minimum thickness: $t_{(min)} \geq 0.9\ t_{(nom)}$

And

$$\frac{t_{max} - t_{min}}{t_{max}} \leq 0.10$$

	Where t_{max}, t_{min} and t_{nom} are respectively the minimum, maximum & nominal thickness. The thickness of insulation mentioned is indicative only. However, the thickness of insulation shall be such that the maximum value of electric stress at the insulation screen shall be 4kV/mm, as indicated elsewhere in the specification.
Core/insulation	
Screen	Extruded semi-conducting layer
Longitudinal Water barrier	Semi-conducting water swellable tape/s.
Radial Moisture Barrier	Extruded lead alloy 'E'. (Nominal thickness not less than 3.0 mm) The minimum thickness of the metallic sheath shall not fall below the nominal thickness by more than 0.1 mm + 5.0% of the nominal thickness. $t_{min} \geq 0.95 t_{nom} - 0.1$
Bedding	Semi-conducting tape/s.
Armour/Screen	Helically applied non-magnetic plain copper wires.
Contact tape	Annealed plain copper tape in open helix.
Water swellable tape	Non-conducting water swellable tape.
Outer sheath	Extruded High Density Polyethylene type ST 7 (black), antitermite treated. Extruded outer conducting layer coated with graphite. Nominal thickness 3.5 mm

6.00.0 GENERAL TECHNICAL REQUIREMENTS OF THE CABLE:

The size of the conductors of the cable shall be sufficient to carry continuously 1250 **Amps** continuously without exceeding a maximum temperature of **90^0C** under site conditions followed by a 20% overload for three hours without exceeding a maximum temperature of 130^0**C for emergency overload** under site conditions. The OWNER estimates that a cross section of 2000 sq.mm Compacted Segmental Circular Milliken conductor would be adequate to carry the stipulated load current.

The conductor size shall be based on loading of the circuit under the conditions indicated in Clause-3.00.00 & 4.00.00 above.

6.01.0 INSULATION CURING:

Dry curing process should be adopted in cross-linking the insulation.

6.02.0 TRIPLE EXTRUSION:

The conductor, screen, insulation and insulation screen shall be extruded in single process. The extrusion process shall be by **VCV method**. The same shall be confirmed in the GTP.

The Cross linked polyethylene insulated (XLPE) cable (Dry cured) shall be manufactured in accordance with the internationally accepted standard and also conform to the requirements of IEC: 62067 for rated voltages from 150KV to 500KV.

6.03.0 DESIGN STRESS AND INSULATION THICKNESS:

The recommended typical design stress values for insulation thickness are:

Design stress a.c.	:	**10 kV/mm**
Design stress impulse	:	**40 kV/mm**

The higher of the two values of the insulation thickness will be adopted but not less than the nominal value of 24.00 mm.

6.04.0 DIELECTRIC STRESSES:

The 220 kV cables shall be designed for continuous operation at a maximum line to earth system voltage of 127 kV. The maximum dielectric stress at the conductor screen and insulation screen shall not exceed the following:

For 2000 Sq.mm

a) At conductor screen **8 KV/mm**

b) At the insulation screen **4 kV/mm**

The dielectric stress at 127 kV shall be furnished by the bidder with calculation sheet.

6.05.0 The cable shall be designed to have a minimum useful life of not less than fifty years. The cable manufacturer should submit a graph showing the breakdown voltage with respect to time for the XLPE insulation compound used. In addition the type of XLPE semi-conducting compound used should be indicated i.e., whether super smooth and purity level.

6.06.0 Each cable length shall be provided with a pulling socket, pulling eye, which shall be fitted to pulling end to withstand the maximum pulling force.

6.07.0 Copper wire screening shall be preferably before the lead sheath to ensure specific water tightness of cable both transversely and longitudinally. However other types of placement of the copper wire screening is also acceptable if it meets the overall technical requirements. The same shall be established by way of Type Test Reports conducted on such cables.

The bidder shall indicate any specific construction features, which will be provided to ensure specific water tightness of cable both transversely and longitudinally.

6.08.0 CURRENT RATING:

The bidder shall furnish the continuous current ratings in ground, in air, in pipes and in ducts at the maximum conductor temperature of 90^0C with reference to the ambient site conditions on the guidelines of IEC 60287. Any additional data, other than furnished under climatic conditions and operating conditions may be suitably assumed. However, the same shall be furnished in GTP for reference. The ratings shall be for Trefoil touching formation when the sheaths are single point bonded and both ends bonded or cross bonded (without exceeding the stipulated sheath voltage of **65 volts** or undue high circulating currents).

The current ratings shall be for single circuit/double circuit in operation.

The bidder shall also furnish technical information on:

i) Derating factors for various types of installation conditions in trefoil and flat (viz., depth of laying, varying ground temperatures, cables in ducts / pipes, cable

spacings, circuit spacings, varying soil thermal resistivities etc.) shall be furnished by the bidder for the following conditions:

(a) Proximity to other 220 kV cables.

- Variation of number of cables (max. 12 in number).
- Variation in spacing.
- Variation in loading of the cables (80% to 100%).

(b) Variation in depth of water table.

(c) Depth of laying cables in trenches and cable ducts.

(d) Depth of **Stabilised Thermal Backfill (STB)** below and above laid cables.

(e) Width of trench on either side of the cables in which **STB** will be put.

(f) Variation in STB effective thermal resistivity.

(g) Variation in soil thermal resistivity.

(h) Laying of cables in long lengths of HDPE pipe, 19 mm thick – Variation due to size and thickness of pipe and open space available in pipe – BIDDER shall suggest methods to improve the ratings.

ii) Short Time Current Loading:

The current loading permissible for a defined period of short time operation, over the cyclic load as under.

Cyclic loading over a 24 hour period.

2100	to	0600 Hours	(9 Hours)	**50%**
0600	to	0900 Hours	(3 Hours)	120%
0900	to	1800 Hours	(9 Hours)	**100%**
1800	to	2100 Hours	(3 Hours)	120%

Furnish short time loading for the following conditions.

i) Only one circuit is live.

ii) When both circuits are live.
iii) When cables are laid in trefoil touching formation.
iv) Single point bonded.
v) Both end bonded.
vi) Cross bonded.

The bidders should furnish GA drawing/other details with supporting calculations on charging current, capacitance, inductance, losses, sheath voltages, sheath currents, surge impedance, sequence impedance and

screen factors, detailed drawings etc., along with the bidding documents.

6.08.1 MECHANICAL CHARACTERISTICS OF CABLE:

The cable shall withstand the electromechanical forces due to peak short circuit currents of **125KA** and shall withstand the stresses of thermal expansion in the insulation due to faults. The cable shall withstand the mechanical stresses during installation.

6.09.0 TEMPERATURE RISE:

The maximum conductor temperature shall not exceed 90^0C during continuous operation at full rated current at 220 kV followed by 20% overload for three hours, maximum temperature not exceeding 130^0C. The temperature after a short circuit for one second shall not exceed 250^0C, with initial conductor temperature of 90^0C.

6.10.0 EMERGENCY LOADING:

The BIDDER shall indicate the maximum percentage overload current that the cable can carry and its duration when operating initially at a conductor temperature of 90^0C and the permissible final conductor temperature after overload. The total period during the lifetime of the cable when it shall be subjected to emergency loading without affecting the expected life of the cable shall also be indicated.

6.11.0 CYCLIC RATING:

The BIDDER shall also indicate the percentage overload current that the cable can carry and its duration, without the conductor temperature exceeding 90^0C due to the time lag in conductor temperature change on account of the change in thermal characteristics of the mass of the soil surrounding the cable.

6.12.0 CABLE MATERIAL:

a) Conductor:

Plain annealed high conductivity copper wires, stranded, segmental conductor while conforming to IEC-60228. The Copper used for the conductor shall be of highest purity. The minimum number of wires and conductors and DC resistance of conductor shall be as per IEC-60228.

b) Conductor Screen:

The conductor screen shall be provided over the conductor by extrusion of semi-conducting compound or by a combination of semi-conducting tape/s and extruded semi-conducting compound. The minimum thickness, excluding tape/s shall be 1.5 mm.

c) Insulation:

Cross-linked polyethylene insulation by dry curing process shall be provided over the conductor screen. The nominal thickness of 24.00 mm and subject to tolerance as per IEC-62067, Clause 10.6.2.

The insulation shall be of high quality, and shall be as far as possible free from contaminants, moisture and voids. The size of voids and contaminants shall be within limits of recognized National/IEC Standards.

The insulation shall be suitable for operation in wet or dry locations at conductor temperature not exceeding 90^0C for normal operation, 130^0C for emergency over load of short duration, and 250^0C for short circuit conditions.

d) Insulation Screen:

Shall be by extruded semi conducting compound and of minimum thickness 1.0 mm.

The semi conducting screens shall be suitable for the operating temperatures of the cable and compatible with the insulation.

e) Moisture Barrier (Longitudinal):

This shall be semi-conducting synthetic non-woven tape with suitable swellable absorbent for longitudinal water sealing covering the whole surface area of the non-metallic part of insulation screening. This barrier shall restrict longitudinal water penetration under the metallic sheath. The nominal thickness of water blocking tape shall not be less than 0.3 mm.

f) Metal Sheath/Moisture Barrier (Radial):

Shall be extruded lead alloy ‘E’ sheath.

The nominal thickness of lead alloy sheath shall be 3.0 mm and shall meet the Electrical and Mechanical properties as per standards. The minimum thickness shall be as per IEC-62067 (Clause 10.7.1).

g) Bedding Tapes:

Suitable semiconducting bedding tapes shall be used under metallic screen of approximate thickness 0.3 mm.

h) Metallic Screen (Armour):

The metallic screen shall be of non-magnetic plain copper round wires, helically applied over the semiconducting bedding tape/s.

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

Note: Requirement of Metallic Sheath/Screen:

The metallic screen can be before or after the lead sheath. However, it shall be as per the manufacturer's type tested design.

The cross section of the metallic sheath that is lead sheath in combination with plain copper round wire screen shall be designed to meet the following requirements:

i) Sustaining the system short circuit rating of **50 KA** for 1 Sec.

   The temperature of metallic sheath at the time of short circuit (cable operating at maximum conductor temperature) shall be indicated in the short circuit calculations of the design of metallic screen/lead sheath.

ii) Ensuring mechanical protection of the cable.

iii) Ensuring radial water tightness of the cable.

Note: Test report ensuring the above compliance has to be submitted by the bidder along with the bid.

i) Outer Sheath:

The outer sheath shall be extruded Black colour High Density Polyethylene, type ST 7 conforming to requirement of IEC. The High Density Polyethylene compound used shall be brand new from a reputed manufacturer and in no case shall recycled material be used.

The outer sheath shall be designed for protection against termite and rodent attacks by adding suitable additives to HDPE compound and such additives shall be harmless to operating personnel. The minimum thickness of outer sheath shall be 3.5 mm.

j) Coating:

A hard baked on layer of graphite shall be applied over the sheath as outer electrode for testing the sheath.

6.13.0 IDENTIFICATION:

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

Brand Name of Manufacturer:

Year of Manufacture:

Voltage rating / conductor cross section: 220,000V/2000 Sq.mm

K.P.T.C.L.

XLPE

7.00.0 CABLE ACCESSORIES:

7.01.0 GENERAL:

Following are the accessories required.

(a) Straight through normal as well as cross bonded joints suitable for directly buried in ground conditions/RCC Cable Ducts.

(b) Outdoor type cable end terminations/GIS module plugin type.

The above accessories shall be suitable for the 127/220 kV, single core 2000 Sq.mm copper conductor lead sheathed cable. The detailed cable construction is given in these specifications under clause 5.01.00

7.02.0 TECHNICAL REQUIREMENTS:

The accessories should be compatible with the size of the conductor, the

insulation and the voltage class of the cable. The components of the accessory shall not be affected by contact with the component materials of cable, and shall not corrode any metal, which they come in contact. The accessory, in the assembled condition, shall be capable of operating under the normal and fault temperature conditions of the cable.

The cable accessories should be procured only from reputed manufactures & type test reports shall be submitted along with the bid.

7.02.1 CABLE JOINT:

The Cable joints shall be suitable for 220 kV Single Core, 2000 Sq.mm copper conductor, lead sheathed XLPE cable and conforming to relevant IEC specification.

The joints shall be suitable for size of the conductor, the insulation, voltage and current ratings of the cable. The required service conditions are horizontal installation, directly buried in earth, laid in RCC cable duct and intermittently or continuously submerged in water.

The BIDDER shall quote for the required quantity of prefabricated type Cable joints which shall comprise of a Factory Tested One Piece Pre Moulded Silicone Rubber joint body moulded from a special Silicone Rubber formulation to provide perfect compression force for optimized electrical performance and afford very simple, reliable, consistent installation. Conductor Jointing should be either with mechanical connectors or a proven crimping technique. Outer mechanical protection with integrated moisture protection must be provided and the manufacturer must provide a detailed description of this. Solderless Jointing technique for the lead sheath and copper wire screen must be provided. Further, the straight through joint shall be able to

(i) Provide a seal against the entrance of moisture or external environment.
(ii) The assembled joint should be resistant to corrosive agents present in the soil, should be mechanically strong to withstand pressure, bending, pulling fatigue. The joint should withstand temperature variations under normal load and fault conditions.

7.02.2 OUTDOOR CABLE END TERMINATION:

The cable end terminations shall be outdoor type suitable for 220 kV SC, 2000 Sq.mm copper conductor, lead sheathed XLPE cable and shall be designed to perform under severe environmental conditions and also conform to the relevant IEC Specifications.

The outdoor termination should have a pre moulded silicone rubber stress cone to provide the electrical stress control function at the end of screen/shield and

should be easily applied without tools It should avoid partial discharges and surface corona under severe service conditions. The cone should be placed on the cable terminated within a pressure tight composite housing made of glass fibre reinforced resin tube with silicone rubber sheds moulded to the tube. The interface between the stress cone, cable insulation and inner housing must be filled with a silicone oil poured from the top. No heating of the silicone oil prior to pouring should be required. It should seal any ingress of atmospheric elements. A flexible double sealing system which is installer friendly must be provided to provide protection against environmental influences. An oil resistant barrier must be provided over the conductor to prevent any oil migration the total creepage distance shall not be less than 6125 mm.

The outdoor termination shall be suitable for the insulation, voltage, conductor size and current rating of the cable.

The sealing ends shall conform to the latest International Standards and shall be of thoroughly proven design. The outdoor type sealing ends shall be suitable for installation in polluted atmosphere referred to in clause 4.00.00 and shall be completely weather proof. Each outdoor type-sealing end shall be supplied complete with four mounting plate insulators to insulate the sealing end from the supporting structures and to control the sheath current. All metallic fittings must be made of corrosion resistant aluminium alloy. Terminal connectors and bimetallic clamps shall also be supplied. Each sealing end shall be provided with consumable materials such as wipes and solvent for cleaning. A Cable Gland for the shield connection and lead sheath connection must be provided and this should be sealed from the external environment with a heat shrinkable sleeve. The power cable leading to sealing end shall be provided with proper sunshield cover.

The material for the housing of the termination should be resistant to tracking, ultra violet radiation (U.V. Exposure) weathering and should have stable hydrophobic properties.

The bidder shall provide necessary arrangement to limit flow of current in the structure supporting the sealing end.

The sealing ends shall withstand the power frequency, impulse and cable testing voltage after installation as specified.

The cable and accessories shall withstand all thermal and mechanical stresses under steady state and transient operating conditions.

7.03.0 TECHNICAL ASSISTANCE/TRAINING:

The successful bidder shall arrange with the suppliers of cable joints and

/ or terminations, the technical assistance in jointing / terminating the cable during installation at the site. The successful bidder shall arrange to train the owner's personnel in jointing and terminating techniques during the installation.

7.04.0 LINK BOXES:

7.04.1 Link Boxes along the run of the 220 kV Cable:

a) Link boxes for grounding of the sheaths of single core cables along the run of the cables shall be made of cast iron/aluminium alloy/stainless steel, suitable for direct burial in the same ground conditions as the cable with anti-rust protection suitable for completely underground installation and for operation when immersed in water. The link box shall conform to IP-66 degree of protection for which the test reports shall be furnished.

   The bidder shall furnish a copy of type tests certificates for the link box offered as per the specification from any of the laboratories indicated in Cl.No. 10.02.10 or any other NABL Accredited Laboratories.

   The design of the box must include a top Lid, which can be lifted vertically. BIDDER to submit the detailed drawing of these boxes along with the Bid. These Link Boxes shall be easily accessible from road surface in case of installation in joint pit. The box shall ensure complete water tightness.

b) These Link Boxes shall be suitable for terminating the cable sheaths on either side of joint bays based on cable route for cross bonding at the box as well as for earthing at recommended locations.

c) All accessories such as copper terminals, cable lugs, connecting links, disconnecting links, washers, gaskets, mounting arrangements, etc., shall be provided to make the system complete.

d) The cross bonding link box shall be designed to be completely water proof and capable of immersion in water.

e) The cable leads from sheath to link box, capable of withstanding 10 kV DC and cable leads from link box to earth shall also be in BIDDER's scope of supply. The BIDDER shall quote for the type of cable leads for the cross bonding system as per the following design:

   Concentric bonding leads of suitable size corresponding to three-(3) nos. co-axial cable entries to the cross bonding box.

   Non–linear resistor type surge divertors of metal oxide type, wherever

required, shall be provided in the link box by the BIDDER.

f) The BIDDER may quote for link boxes of suitable design in which the surge voltage limiters (SVLs) do not need to be disconnected when a routine 10 kV DC test on the cable outersheath is performed.

7.04.2 Link boxes at the circuit end:

The lead sheath shall be grounded through suitable disconnecting links at the base of sealing ends. The BIDDER shall clearly indicate whether the links are to be grounded directly or through SVLs (non-linear resistors). The links shall be housed in a weather proof, outdoor, galvanised sheet steel box or cast iron or aluminium alloy box with mounting brackets and provided with 'O' Ring gasketted door. The cable leads from the sheath to the link box, capable of withstanding 10 kV DC & cable leads from link box to earth shall form a part of the scope of supply of the BIDDER. The Bidder shall quote for the same.

7.04.3 Cross Bonding of cable sheath:

The BIDDER shall give his recommendations regarding cross bonding of cable sheaths for the flat formation of single core cables. The BIDDER shall clearly indicate the number of joints to be directly earthed and those to be earthed through zinc oxide (Z_nO), non-linear resistors (sheath voltage limiters). The offer may indicate a suitable design whereby Z_nO resistors need not be disconnected while conducting routine DC test on the over sheath.

The sheath standing voltage to earth for rated cable current shall not be in excess of 65 V RMS.

The sheath voltage, during an external three phase, symmetrical through fault as specified, should not be in excess of 3.3 KV for 3 sec.

The BIDDER shall indicate the arrangement considered by him in his proposal to meet the above requirements with suitable non-linear resistors, if required, to limit the sheath voltage.

Detailed calculations for sheath voltages as per recommended bonding methods shall be furnished along with the bid.

The BIDDER shall indicate permissible variation in the lengths of the 3 minor sections of a major section, which will not affect the efficacy of the cross bonding.

The BIDDER shall confirm that the cable can be continued in service in the event of a sheath fault and shall indicate the de-rating of the cable in case of an earth on the sheath at the link box earthed through SVLs.

Transposition of cables:

The BIDDER shall indicate and provide arrangement for transposition of cables if necessary along with cross bonding. The Details of the same shall be furnished alongwith the bids.

7.04.4 VOID

7.04.5 VOID

7.04.6 Partial Discharge (PD) Measurement System: VOID

7.05.0 DTS (Distributed Temperature Sensor) with RTTR: void

7.06.0 SHEATH BONDING CABLE AND EARTHING CABLE:

The sheath bonding cable shall be co-axial cable 6.6 kV and above grade with 400/400 Sq.mm (conductor/concentric conductor) stranded Copper conductor PVC insulated wire armoured and PVC sheathed. The earthing cable shall be 3.3kV & above grade with 400Sq.mm stranded copper conductor PVC insulated & PVC sheathed. However the rating and the size of sheath bonding cable and earthing cable mentioned are indicative and minimum values. The bidder may quote the actual rating and size of cable offered, to meet the requirement.

7.07.0 PIPE EARTH STATIONS:

The earthing shall be as per provisions of IS:3043, Code of practice for earthing and as per IE rules:1956 Or its Latest Amendments.

8.00.0 ELECTROLYSIS AND CORROSION:

The cable serving shall be designed such that the cable sheath and armouring are protected from electrolysis caused by stray currents, from galvanic action and from corrosion and microbiological attack. The design of accessories shall be such that the outer metallic coverings of cable joints, sealing ends and control points can be insulated from earth along the entire route so that cathodic protection, if needed can be applied and also periodic testing of the insulating resistance of the serving can be done. A set of links shall be provided at each end of cables to connect the cable sheath and armour to the respective station grounds. The sealing ends shall be suitably insulated from their supporting structures, to permit insulation test on the cable over sheath.

9.00.0 GROUNDING SYSTEM:

The BIDDER shall indicate his recommendations regarding the type of grounding systems for the lead sheath/armour. The scope of supply shall include ground rod or ground conductor as recommended. The grounding material shall be copper.

10.00.1 TESTS ON CABLES AND ACCESSORIES:

10.01.0 APPLICABLE STANDARDS:

The testing procedures and requirements shall conform to the latest edition of the following national and international standards, but not limited to:

a) IEC publication 60540
b) IEC publication 60228
c) IEC publication 60229
d) British Standard Specification 6622
e) IEC publication 60840 ***(only applicable Sections of the Standard)***
f) IEC publication 60230
g) IEC publication 60287
h) IEC publication 60811
i) IEC publication 60885
j) IEC publication 62067

The IEC Standards shall prevail whenever the same tests are specified in other standards.

10.02.0 TESTS:

10.02.1 The Owner is keen to procure cables of highest integrity. To provide adequate confidence to the owner for the long term reliability of the cables, the manufacturer has to carry out the prequalification tests on cables and their accessories in accordance with IEC-62067:2011.

The prequalification tests should have been conducted on complete cable system as per clause 13 of IEC-62067.

Prequalification test report shall be furnished along with the bid documents, which is mandatory.

The prequalification tests are to determine long term reliability of a cables

system. Hence it is necessary to carry out a long term accelerated ageing test. This test is to be performed as per clause no. 13.2 of IEC-62067 on the complete system comprising cables (specified in Tender) joints and termination in order to demonstrate the performance of the system.

The bidder shall enclose a detailed report of prequalification test as per clause No.13.2 of IEC-62067 along with the bid.

After qualification of these tests, regular routine, acceptance and type tests are to be conducted in any one of the approved labs as indicated in the clause 10.02.10 on the samples and cables manufactured for the Owner.

10.02.2 The bidder shall include the field test report of similar size and voltage class cables installed in actual service. The report shall include voltage class, size, actual voltage, actual load current data, sheath voltage, sheath/conductor temperature data and all events after installation during service of such cable till date etc.

10.02.3 Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests in the activity schedule.

10.02.4 Acceptance tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of the lot.

10.02.5 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the cable to check requirements, which are likely to vary during production and to demonstrate the integrity of the cables to be delivered to the customers for use.

10.02.6 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Bidder to ensure the desired quality of the end product to be supplied by him.

10.02.7 The Standards and norms to which these tests will be carried out are mentioned elsewhere in these specifications. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be mutually agreed to between the Bidder and the Owner in the Quality Assurance Programme.

10.02.8 For all type and acceptance tests, the acceptance values shall be the

values guaranteed by the Supplier in the proforma for "Guaranteed Technical Particulars", furnished in this Specification or acceptance value specified in this specification, whichever is more stringent for that particular test.

10.02.9 All tests – routine, acceptance and type tests shall be as per IEC-62067 and its Latest Amendments.

10.02.10 The adequacy of Partial Discharge detector used for Partial Discharge tests required for drum lengths of cables under routine tests must be demonstrated by performing tests as per IEC-60885 (3) – 1988.

The bidder shall furnish a copy of type tests certificates for the cable and accessories offered as per the specification from any of the following laboratory on similar cable and accessories as offered for this tender in compliance with IEC:62067, CL.No.12.2: Range of Type approval. The test should have been conducted within the last 10 years as on the last date of submission of bid. No charge is payable by the owner for the type tests.

a) For cables & accessories manufactured in India:

i. Type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by Government or accredited by National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.

ii. Type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.

iii. The type tests conducted in-house by manufacturers shall also be acceptable where the specific test facilities are not available in independent NABL accredited laboratories provided the lab (manufacturer's) is accredited by National accreditation body of the country and the tests have been witnessed by a representative of NABL accredited Independent laboratory/Power utility.

b) For cables & accessories manufactured Abroad:

i. Type tests on imported equipment should have been conducted in an Indian laboratory or foreign laboratory accredited by National accreditation body of respective country.

ii. Type tests conducted in-house by manufacturers shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests have been witnessed by a representative of accreditation body/Power utility.

Following are the type test reports which are to be enclosed/uploaded in the bid.

1) Prequalification test – (Cl. 10.02.1 of specification)
2) Electrical Type tests as per – (Cl. 10.03 (1)(a) to (j) of specification).
3) Non-Electrical Type tests as per – (Cl. No. 10.03 (2) (a) to(o) of specification).
4) Special test as per- (Cl. 10.06 (a) (i) & (ii) of specification)
5) Type test for Link box- (Cl. No. 7.04.1 of specification)

10.02.11 Tests to be conducted during the supplies/after completion of supplies for acceptance of cable and accessories will be at the discretion of the Owner.

1) CABLE:

The owner will select at random a test sample of cable from the lot and subject it to **either a particular type test or** full range of type tests as per IEC-62067: 2011 at any reputed testing house or Laboratory or at manufacturer premises to be approved by KPTCL.

The bidder shall prepare the sample for tests and organize testing.

The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner.(Refer Note (e) given below).

If the cable fails in any of the type tests, the entire lot of cable will be rejected.

2) JOINTS & TERMINATION:

Two Terminations and one joint will be selected at random out of the supplies and subjected to **either a particular Type test or** full range of type and other tests at any reputed testing house/laboratory to be approved by KPTCL as per Clause IEC 62067: 2011 and tests shall be carried out accordingly.

The bidder shall prepare the sample for tests and organise testing. The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner.(Refer Note (e) given below).

If the sample under test i.e., cable / joint / termination fails, the entire lot of cable / joint / termination will be rejected.

3) The tests mentioned in (1) & (2) above are independent of the type test reports already furnished by the supplier.

NOTE:

(a) The waival of any type tests shall be at the sole discretion of the owner.

(b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

(c) The cost towards **each** type test shall be clearly indicated **seperately** in the bid and the same will be included for bid evaluation.

(d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

(e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected.

The type test charges shall be paid upfront by the firm/bidder even though the same is on the behest of KPTCL. However such type test charges as per actuals shall be reimbursed to the firm/bidder in case the cable passes the type tests successfully. Type test charges will not be reimbursed if the cable fails in the type test.

10.03.0 TYPE TESTS ON CABLE SYSTEM (CABLES & CABLE ACCESSORIES):

The following type tests comprising the electrical tests on the completed cable and the appropriate tests on the cable components shall be conducted in any of the laboratory to be approved by KPTCL in the presence of the owner's representative.

The owner may at his discretion, waive the type tests, modify the tests, request for additional tests.

1) The type tests and sequence of electrical test (as per following clauses of IEC

62067) on complete cable system shall be:

a) Bending Test on the cable (Cl.12.4.3) followed by installation of accessories and a partial discharge test at ambient temperature (Cl. 12.4.4)

b) Tan Delta measurement (Cl:12.4.5)

c) Heating cycle voltage test (Cl:12.4.7)

d) Partial discharge test (Cl:12.4.4)

- at ambient temperature, and

- at high temperature.

e) The tests shall be carried out after the final cycle of item (c) above or alternatively, after the lightning impulse voltage test in item (f) below.

f) Switching impulse voltage test (required for Um ≥300kV Cl.12.4.7.1)

g) Lightning impulse voltage test followed by a power frequency voltage test (Cl.12.4.7.2)

h) Partial discharge tests, if not previously carried out in item (d) above.

i) Tests of outer protection for joints (Refer annexure G):

j) Examination of the cable system with cable and accessories on completion of the above tests (Cl. 12.4.8)

k) The resistivity of the cable semi-conducting screens (Cl. 12.4.9) shall be measured on a separate sample.

2) The Non Electrical type tests (as per the following clauses of IEC 62067) on cable components & on completed cable shall be:

a) Check the cable construction (Cl. 12.5.1)

b) Tests for determining the mechanical properties of insulation before and after ageing (Cl. 12.5.2)

c) Tests for determining the mechanical properties of oversheaths before and after ageing (Cl. 12.5.3)

d) Ageing tests on pieces of complete cable to check compatibility of materials (Cl. 12.5.4)

e) Pressure test at high temperature on oversheaths (Cl. 12.5.6)

f) Hot set test for EPR and XLPE insulations (Cl. 12.5.10)

g) Measurement of density of HDPE insulation (Cl. 12.5.11)

h) Measurement of carbon black content of black PE oversheaths (ST_3 and ST_7) (Cl. 12.5.12)

i) Test under fire conditions (Cl. 12.5.13)

j) Water penetration test (Cl. 12.5.14)

k) Tests on components of cables with a longitudinally applied metal type or foil, bonded to the oversheath (Cl. 12.5.15)

Note: All the applicable tests as per IEC-62067 shall be conducted for the cable requirement of this specification.

10.04.0 ROUTINE TESTS ON CABLE AND ON THE MAIN INSULATION OF PREFABRICATED ACCESSORIES:

The following tests (as per following clauses of IEC-62067) shall be carried out on each manufactured length of cable:

a) Partial discharge test (Clause 9.2).

b) Voltage test (Clause 9.3).

c) Electrical test on over sheath of the cable (Clause 9.4).

d) Conductor resistance test (Clause 10.5).

10.05.0 ACCEPTANCE TEST / SAMPLE TESTS ON CABLES:

The following tests (as per following clauses of IEC-62067) shall be carried out on samples.

a) Conductor examination (Clause 10.4).

b) Measurement of electrical resistance of conductor and of metal screen/sheath (Clause 10.5).

c) Measurement of thickness of insulation and oversheath (Clause 10.6).

d) Measurement of thickness of metallic sheath (Clause 10.7).

e) Measurement of diameters, if required (Clause 10.8)

f) Hot set test for XLPE and EPR insulation (Clause 10.9).

g) Measurement of capacitance (Clause 10.10).

h) Lightning impulse voltage test (Clause 10.12).

i) Water penetration test, if applicable (Clause 10.13)

Note: All the applicable acceptance tests/sample tests as per IEC-62067 shall be conducted for the cable requirement of this specification.

Frequency of Acceptance Tests:

The acceptance tests shall be conducted on one drum length from each manufacturing series of the same type and size of cables, but shall be limited to not more than 10% of the number of drum lengths, rounded to upper unity. However, water penetration test & lightning impulse test shall be on one length for the order upto 20Kms and two lengths for more than 20kMs order.

10.06.0 (a) SPECIAL TESTS ON CABLES:

The following are the additional special tests:

i) Short circuit test on metallic wire screen and lead sheath, in combination at 50kA for 1 Sec with conductor temperature during the test at 90^0C.

ii) Test for ovality of the core.

iii) (a) The waival of type tests shall be at the sole discretion of the owner.

(b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

(c) The cost towards type tests shall be clearly indicated in the bid and will be included for bid evaluation.

(d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected

10.07.0 SPECIAL TEST ON ACCESSORIES:

10.07.1 JOINTS

Cyclic ageing test under water.

The Test shall be conducted as per IEC 62067 Annexure – G

10.07.2 OUTDOOR TERMINATION:

The outdoor termination should meet the following additional test requirements

(i) Power frequency voltage wet withstand test as per latest version of IEC-62067 standard.

(ii) Salt fog test as per IEC.

(iii) Material test (if applicable)
   a) Tracking and erosion resistance
   b) Thermal ageing
   c) Weather resistance

10.08.0 ADDITIONAL TESTS:

Following tests shall be carried out as per IEC-62067: 2011, Cl. No. 16.0 on the complete installation after completion of cable laying, jointing and providing all necessary accessories.

a) Insulation resistance test.

b) DC voltage test of over sheath & AC voltage test of the insulation in accordance with IEC-62067: 2011 (Cl. No. 16.2 & 16.3).

c) Site tests on non-metallic sheaths in accordance with latest version of IEC-60229.

The supplier shall also indicate any additional special test at site recommended by them to ensure satisfactory operation.

10.08.1 The Bidder shall furnish all the testing details in a compact disc (CD).

10.09.0 GUARANTEED LOSS:

Regarding guaranteed losses, measured losses and capitalization of losses for the purpose of evaluation of the offer refer respective clause in SCC of bid document.

11.00.0 IDENTIFICATION:

The Cable should be identified by embossed letters in English as per Clause 6.13 of technical specification.

The accessories shall be marked with voltage class, size of cable conductor, manufacturers name or trademark, date of manufacture and relevant technical information.

12.00.0 QUALITY ASSURANCE PLAN:

a) The bidder shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i. Structure of the organization.

ii. The duties and responsibilities assigned to staff for ensuring quality of work.

iii. The system of purchasing, taking delivery and verification of materials.

iv. The system for ensuring quality of workmanship.

v. The quality assurance arrangements shall conform to the relevant requirement of ISO-9001 or ISO-9002 as applicable.

vi. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of suppliers representative, copies of test certificates.

vii. List of manufacturing facilities available.

viii. Manufacturing process shall be fully automatic with dust proof/Air conditioned working atmosphere.

ix. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

x. List of testing equipment available with the bidder for final testing of equipment specified and test plant limitation, if any vis-à-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the “Schedule of Deviations” from the specified test requirements.

xi. Level of automation achieved & test of areas where manual processing exists.

b) The Successful bidder shall within 30 days of placement of order, submit

the following information to the Owner.

i. List of raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.

ii. Type test certificates of the bought out accessories if required by the Owner.

iii. Quality Assurance Plan (QAP) with holds points for owner inspection. QAP and owners hold points shall be discussed between the owner and successful bidder before the QAP is finalized.

iv. The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing if required by the owner and ensure that the quality assurance requirements of specifications are followed by the sub-contractor.

c) The Quality Assurance Programme shall give a description of the Quality System and Quality Plans with the following details:

i. Quality System

- The Structure of the organization.
- The duties and responsibilities assigned to staff for ensuring quality of work.
- The system of purchasing, taking delivery and verification of materials.
- The system of ensuring quality workmanship.
- The system of control of documentation.
- The system of retention of records.
- The arrangement of successful bidder internal auditing.
- A list of administrative and work procedures required to achieve successful bidder quality requirements. These procedures shall be made readily available to the Owner for

inspection on request.

ii. Quality Plans:

- An outline of the proposed work and programme sequence.
- The structure of contractor's organizations for the contract.
- The duties and responsibilities ensuring quality of work.
- Hold and notification points.
- Submission of engineering documents required by this specification.
- The Inspection of the materials and components on request.
- Reference to successful bidder work procedures appropriate to each activity.
- Inspection during fabrication/construction.
- Final inspection and test.

The Owner reserves the right to seek documentary proof of the source of material (insulation, outer sheath, and other cable components) and to cross check with the supplier.

13.00.0 INSPECTION:

Inspection may be carried out by the owner at any stage of manufacture. The successful bidder shall grant free access to the owner's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the owner shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the owner informed in advance about the manufacturing programme so that arrangement can be made for inspection.

13.01.0 The owner can depute upto Five Engineers from KPTCL for inspecting the equipments/materials. The Visa, to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the Contractor.

13.02.0 The owner reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items.

13.03.0 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested in presence of the owner's representative and cleared for despatch.

13.04.0 The supplier shall give 30 days advance intimation to enable the owner to depute his representative for witnessing type tests, acceptance and routine tests.

14.00.0 PACKING AND MARKING:

14.01.0 DELIVERY LENGTH OF CABLE:

It is important to note that the correct delivery length on each drum and the total number of drums to be delivered shall be ascertained by the successful bidder before manufacture, by cable route survey and approval of the owner.

The inner diameter of the drum shall not be less than 20 D and the minimum delivery length of the cable on each drum shall be approximately 500 Mtrs (Five Hundred) subject to approval of the owner.

14.02.0 The cable shall be wound on non-returnable strong steel drums. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks. The ends of the cable shall be sealed with good quality heat shrink sealing caps. The required additional sealing caps of sufficient quantity shall be supplied for use for testing during laying and jointing at site and to seal spare lengths of cable.

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

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

(i) Name and address of the Manufacturer, Trade name/Trade Mark/Brand.

(ii) Size of cable (cross section) rated voltage, standard, insulation, cable code, drum number, year of manufacture.

(iii) Length of cables (metres).

(iv) Direction of Rolling.

(v) Net weight (in Kg).

(vi) Gross weight (in Kg).

(vii) Purchase order reference.

Note: a. Economic drum length shall be got approved from the owner during the survey of route by the successful bidder and inner drum diameter shall not be less than 20 D.

b. Each cable end shall be hermetically sealed by means of metal cups using wiping lead so as to protect the cable from moisture penetration during transit, storage and laying. Pulling tension shall be furnished by the successful bidder.

c. The vendor shall be responsible for any damage to the cables during transit due to cable or reels not having been properly fastened, packed and secured.

d. Two Nos. of swivels of suitable capacity shall be supplied along with the first batch of cables free of cost.

e. The maximum weight of cable along with drum to be furnished by the successful bidder before execution of works.

Handling and Storage:

All accessories and spares shall have a minimum shelf life of 10 years, detailed instructions for storing accessories and all equipments which are supplied by the vendor shall be indicated.

15.00.0 DESPATCHES:

No dispatches shall be made without approval from the Owner to the test certificates. All dispatches shall be made to the consignees intimated by the owner.

16.00.0 CABLE LENGTHS:

The correct total quantity, the number of drums, the length of cable on each drum shall be ascertained by the successful bidder from the owner, at the time of manufacture. This is in view of any change in the already finalized route plan, profile which may arise due to any unforeseen circumstances between the period of placing the order and commencement of manufacture.

17.00.0 DELIVERY AT STORES/SITE STORES:

The stores / site is located at Bangalore. All regulations governing the transport of goods by various modes of transport shall be observed by the contractor.

It will be the sole responsibility of the successful bidder to deliver the goods safely at the owner's stores / site stores, including handling and unloading etc.,

18.00.0 INSTALLATION:

18.01.0 SURVEY – ROUTE PLAN:

18.01.1 The bidders are requested to fully inform and acquaint themselves on the local site conditions, which have a direct bearing on the cost estimates and execution of the work.

The tentative cable route plan is furnished to the bidder, indicating roads, position of road crossings, railway crossings, drainage crossings etc., in the drawing enclosed with the bidding document. In case of Variations during actual survey or any deviations in quantity, payment would be made as per quantities executed as per actuals.

The successful bidder shall make a detailed survey of the cable route, by excavating the trial pits as warranted by the local conditions and prepare necessary drawings. All relevant data, required shall be properly recorded and preserved for future use and to decide on requirements of:

- Cable delivery length per drum
- Proposed cable sections
- Location of joint bay positions
- Type and quantity of joints required
- Final cable route plans
- Design of cable ducts/trench for road crossings drainage crossings, railway crossings etc.
- Identify locations for bonding.
- Trench with brick masonry side wall and pre-cast reinforced concrete slabs.

The survey data on the cable route should also include recording of the information required for cable design, such as

- Type of soil along the cable route, soil resistivity

- Soil thermal resistivity, PH Value
- Sub soil water locations and other relevant information in designing the ducts and pipes for cable.

NOTE: The quantities executed will be paid at actuals.

18.01.2 LOCATION OF JOINT BAYS:

The location of the joint bays should be carefully decided to avoid, traffic hazards, collection of subsoil water and any possibility of flooding due to storm waters. The joint bays located should be easily accessible for inspection and tests.

18.01.3 CABLE LENGTH, SECTIONS:

The maximum and minimum delivery lengths of cable that can be supplied shall be furnished by the bidder in the tender.

The successful bidder shall carryout a final route survey, fix joint bay locations and finalize the sections and delivery lengths.

A tolerance of ±1% may be assumed while finalizing the actual cable length.

The work on installation and laying of cables will be taken up by the successful bidder only on approval of the route plans by the owner.

18.01.4 CABLE INSTALLATION RECORDS:

The route plan records / drawings, and the final route map drawings after installation and commissioning, should be furnished to the owner. Three transparencies and nine zerox copies each of route plan and 2) Final route map after installation shall be furnished. Soft copy of the same shall be furnished in CDs.

18.01.5 For preparation of cable route plans and cable records, relevant sections of Indian standards publication IS:1255, “Code of Practice for installation and maintenance of power cable”, or any other appropriate international standard may be referred for guidance.

18.01.6 SOIL THERMAL RESISTIVITY / SOIL RESISTIVITY:

The successful bidder shall investigate the soil characteristics along the cable route, at the required laying depths to evaluate the parameters governing the cable design.

The thermal resistivity tests should be carried out at every 200M interval

along the cable route and also at specified locations at the direction of the owner. At each location the thermal resistivity tests are to be taken at three different depths and two soil samples are to be taken for further laboratory analysis.

The laboratory analysis of the soil samples collected from the site should be conducted in detail, including soil identification, moisture content, density, organic content, critical moisture content of each soil type encountered along the route to arrive at the thermal resistivity values of the native soil.

These tests should be conducted by using reliable measuring instruments with fully automated thermal property analyser and thermal probes, through reputed agencies, like GEOTHERM, CPRI, Technical Institutions & any other competent organisations. KPTCL will depute its Engineers to witness these tests.

The generally assumed value of the soil thermal resistivity may be taken as 150^{0}C Cm/w.

The OWNER anticipates the presence of soil strata at a few locations along cable routes with a soil thermal resistivity of more than 150^{o}C Cm/w.

However, the successful BIDDER shall be responsible to ensure that no derating of the cable will take place on account of variation in soil thermal characteristics. In consultation with the OWNER, the BIDDER shall analyse and indicate the appropriate backfill (STB – Soil Thermal Backfill) recommended. Bidder will have to design the trench optimally to take care of local site conditions. The maximum permissible soil thermal resistivity shall be limit to 120^{o}C Cm/w in fully dried condition out of the locally available materials to achieve maximum current capacity for the cable section used. BIDDER shall ensure that no derating of the cable takes place on account of soil/backfill thermal characteristics and that proper backfill is used.

In conformity with the above requirement, the BIDDER shall determine and advise on the following:

- Optimum design of trench to take care of local hot spots and methods to reduce effective Thermal resistivity value.

- The type of graded sand to be utilized by sieve analysis as one of the components of the STB backfill to obtain tight fit soil.

- The optimum Kaolinitic clay content in the soil to make it less porous and

of high specific surface area for optimum moisture retentivity suitable for areas prone to moisture migration on account of low water table.

- The material and composition of thermal backfill will be finalized during detailed Engineering. Bidder shall be responsible for ensuring the best “effective” thermal resistivity.

Subsequent to completion of backfilling, in-situ measurements of soil thermal resistivity, dry cured density, void ratio, moisture and clay contents of the soil shall be carried out by the BIDDER along the cable routes at regular intervals mutually agreeable to the BIDDER and PURCHAER, using his own instruments as a quality check on the backfill employed and method of back-filling and detailed report shall be submitted by BIDDER.

However, the successful bidder shall carry out the required investigation and tests to evaluate and determine the soil resistivity and soil thermal resistivity along the cable route, at cable laying depth, to the satisfaction of the owner.

18.01.7 THERMAL BACKFILLS:

The successful bidder shall design, specify supply formulate, test and lay a suitable backfill, only if the owner desires and with the prior approval of the owner, if found necessary after the receipt of the route survey report for thermal characteristics of the soil.

18.02.0 Laying and installation of Cables:

18.02.1 General

The successful bidder shall carry out all activities connected with the laying and installation of the power cables, and completion of the work for which the project is intended and to the full satisfaction of the owner.

Notwithstanding subsequent changes/alterations in route/design, the bidders shall quote in their bid proposals for carrying out the cable installation work as per the specifications of the owner, which will be considered for bid evaluation.

However, alternate route/installation arrangements offered from the bidders, with clear justification for these alternatives, will be considered by the owner, if they prove to be of a better and economical design and also the quoted bid value is the lowest.

18.02.2 Scope

This scope covers the proposed method of cable laying, in ground i.e., directly buried in ground with laying in ducts, pipes and in air. The excavation and construction of R.C.C., stone masonry, brick masonry ducts, laying of pipes for installing cable and also for the construction of jointing bays as per requirement of the field conditions.

The scope also includes supply of all requisite materials, labour, tools and plant like sand, brick, stones, steel, cement aggregate for reinforcement, pipes, joint and route markers and all other consumables required for the completion of this work.

The bidder shall insure for materials. The bidder shall handle, load, transport, unload and store all materials at site and arrange for security, till commissioning and handing over to the owner.

18.02.3 Drawings

The bidder shall prepare the drawings for the applicable field conditions of cable installation, like cables directly buried, in ducts, in road crossings, on drainage crossings, railway crossings, cable jointing bays, manholes if any, and furnish 6 copies of each to the owner for approval.

All works are to be executed only after due approval of the competent authority and under the supervision of the engineer in-charge.

18.02.4 Specifications

These specifications are intended for general description of quality, of materials and workmanship of finished work.

They are not intended to cover the minute details. The work shall be executed in accordance with the best modern practices, Indian standards (I.S.) and other relevant codes.

The specifications, referred to above are I.S. Standards relevant to Civil Engineering works and cable laying works.

The specifications shall be read in conjunction with the other parts of the bid documents.

The owner's decision shall be final on any issue in respect of installation.

18.02.5 Installation of U.G.Cables

Installation: The cables shall be laid generally in "directly buried in ground/in RCC cable duct in Trefoil touching formation to form 220 KV 3 single core, single circuit system. However, as per requirement of the field, the cables may also have to be laid;

- in ducts/trenches.
- in HDPE pipes in trefoil/horizontal formation (pipes to be filled with sand/suitable material after cabling).
- in Air at terminations.
- At varying depths due to obstructions.
- As per approved drawings.
- In HDPE pipes for railway crossing

18.02.6 Inspection, Storage and Handling

The successful bidder should take all necessary precautions for inspection of cables on receipt, and for the proper handling and storage. The successful bidder shall have his own arrangement for transporting the cables, materials, equipment to site and back to store.

The cables shall be stored on hard packed surfaces and protected from harmful weather conditions.

The cable drums shall be mounted and transported on only approved type cable drum conveyors. The cable should not be bent beyond permissible limits of the bending radius while laying and jointing.

18.02.7 Statutory Clearances

The installation of cables shall be as per established code of practice and fulfill the requirements of statutes. Obtaining all statutory clearances from other utility services, like telephones, water supply, power supply, Railways, National highways, Bengaluru Mahanagara Palike and other Local Administrative Authorities for road cutting etc., for laying the cable will be responsibility of the successful bidder.

All necessary approvals of the concerned authorities to be obtained before execution of the works by the successful bidder and necessary assistance

will be rendered by the owner.

Charges to the civic/national highways/traffic/defence authorities/Railway/ Telephones/Water supply/Power supply/MahanagaraPalike and other Local Administrative authorities etc., as per their standard schedule of rates for grant of permission/approvals for trenching/laying pipes/laying cables etc., are to be paid by the successful bidder. These charges are reimbursable by the owner as per actuals, on production of valid vouchers.

Restoration of the surface to its original condition as per the requirements of the concerned authorities is also included in the scope of the work. (Necessary specification of Bengaluru MahanagaraPalike is included in the Annexure).

The Restoration of the surface shall be carried out as specified in Annexure -1 of the technical specifications (Volume-II) of the tender document.

It is the responsibility of the bidder to ensure the restoration of the surface in complete in all respect before handing over to KPTCL.

18.02.8 Trench/RCC Cable duct

The cable trench/RCC cable duct work involves earth excavation for cable trench/Excavation and Construction of RCC cable duct, back filling and removal of excess earth from site. The work site shall be left as clean as possible after completion of the work.

The earth for construction of trench/RCC cable duct shall be excavated using manual and mechanical modes as per field conditions. Most of the roads are of asphalt surface and some are with cement concrete surface.

An air compressor with pneumatic drill or equivalent mechanical tool will be essential for the road crossings and railway crossings involve horizontal drilling i.e., Trench-less cutting wherever necessary.

Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly restored.

The sides of the excavated trenches/RCC cable duct shall wherever required, be well shored up with timber and sheeting.

Suitable wooden barriers should be erected between the cable trench and

pedestrian / motor way/railway to prevent accidents. The barriers could be made out of Jungle Wood / Deal Wood Planks. These could be portable types of size 1.5M (long) by 1.2M (Height). These barriers should be painted with yellow and black or red and White coloured cross stripes. Warning and caution boards should be conspicuously displayed. Red lights as warning signal should be placed along the trench during the nights and any other requirements as per the traffic authorities directions.

The excavated material shall be properly restored immediately after laying the cable by mechanical compactness to avoid obstruction to public and traffic movement.

The cable shall be laid immediately after formation of trenches. The bottom of the excavated trench should be levelled flat and free from any object, which would damage the cables. Any gradient encountered in trench/cable duct shall be gradual.

18.02.9 Cable Handling

The inspection of cable on receipt, handling of cables, paving out, flaking, cushioning with sand or sieved compacted native soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, preparation of all chambers, sump holes and all necessary precautions that are required shall be carefully planned and in general conform to latest edition IS 1255 - 1983 or its equivalent.

18.02.10 Damage to Property

The successful bidder shall take all precautions during excavation of trench/RCC cable duct trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the owner.

The successful bidder shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

18.02.11 Cable over bridges:

Wherever the cable route crosses the bridges, the cables shall be laid in ducts.

18.02.12 Cable crossing open drains with long span

1) Wherever the cable route has to cross an open drain, with a long span, the cable shall be laid in suitable size ducts, or pipes, suitably jointed with collars. The entire duct system shall be designed as per civil engineering

practice and shall be got approved by the concerned authorities and owner.

2) At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes.

18.02.13 Cable route markers / cable joint markers.

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per drawings approved by owner.

Markers provided shall be as per the field requirement. If the route passes through open fields, markers should be conspicuously visible and above ground surface.

The marker should incorporate the relevant information: The name of the owner, voltage, circuit and distance of cable from the marker.

18.02.14 Laying of Power Cables

The 220 KV, single-phase cables shall be laid in Trefoil formation, forming one circuit laid in the trench/duct complying with all applicable standards as per drawings approved by the owner.

The cables shall be laid wherever required in HDPE pipes of ISI approved quality.

When cables are laid in RCC hume pipes, the following points shall be taken care of.

i. If one cable (single phase) is laid through the Cement Concrete pipe, the CC pipe should not have reinforcement of steel rods.

ii. The cable should occupy only 30-40 % of the area of the cross section of pipe.

iii. The CC pipes shall be backfilled by sand after installing the cable.

iv. The cables shall be protected by covering with a pre-cast RCC slab of approved design and marking throughout the length of the route.

18.02.15 Identification

An identification marker/Tag of lead of size 50 mm x 25 mm x 2mm shall be provided at 2.5 meter intervals throughout the route length of the cable and fastened with a suitable nylon string. The marker shall be embossed/punched on both sides with the letters, KPTCL, 220 KV, CKT-1, Phase identification by coloured PVC tape shall be at 1M interval. Alternatively plastic tags may be used. These tags should also be fixed,

at the cable inlet and outlets of a duct, tunnel, manhole and joint bays.

18.02.16 Warning Tape:

A prewarning, Red colour plastic /PVC tape, 150 mm wide 100 microns thick, shall be laid at specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under CAUTION; KPTCL, 220000V CABLES.

18.02.17 Paving out the cable

The excavated cable trench/RCC cable duct shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paving out the cable. The cable shall be rolled in the trench/RCC cable duct on cable rollers, spaced out at uniform intervals. The paving out process must be smooth and steady without subjecting the cable to abnormal tension. For this power winch, power roller – both straight and angle roller, may be used. The cable on being paved out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables shall never be dropped. All snake bends shall be straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension loading shall be by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed not exceeding 600 to 1000 mtrs per hour.

The cable end seals shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores, for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct.

18.02.18 Flaking:

The cables shall be flaked and left with slight extra lengths at jointing bays for expansion and flexibility.

18.02.19 Sand Cushion:

The sieved sand cushion for the cables shall be provided as per the drawings. Sand covering shall be done by hand and in such a manner as to provide complete envelope for the cables and a good bedding for protection covers

18.02.20 Thermal Backfill:

Based on the evaluation of soil thermal resistivity along the cable route and after approval from the owner the successful bidder shall design, specify, supply, lay & monitor the installation of thermal backfill surrounding the cables.

18.02.21 Immediate Envelope To Cable

The option on the use of the material, which immediately envelops the cable viz., thermal backfill or sand or sieved native soil rests with the owner. The successful bidder shall seek prior approval on the use of the envelope material from the owner before execution of the works.

18.02.22 Prevention of damage due to sharp edges

After the cables have been laid in the trench/RCC cable duct and untill the cables are covered with protective covering, no sharp metal tool shall be used in the trench/RCC cable duct or placed in such a position that may fall into the trench/RCC cable duct.

Straight and curved (angle) rollers used shall have no sharp projecting parts liable to damage the cable.

While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct..

The cables shall never be bent, beyond the specified bending radius.

18.02.23 Road Crossings:

The road cutting work for cable trench/RCC cable duct whether cement concrete, asphalt or macadam road surface shall be taken after obtaining approval for cutting from the civic authorities, traffic police, telephone authorities and work should be planned to be completed in the shortest possible time. Whereever necessary the work shall be planned during night time or light traffic periods.

In the excavated trench across the road, the cables shall be laid in HDPE pipes, pipes are embedded in RMC (Ready mixed cement concrete) 1:2:4 proportions, excavation backfilled, compacted and the surface shall be redone in the shortest possible time as per the requirements of the civic authorities.

18.02.24 Footpath Cutting:

The slabs, kerbstones, on the roads shall be removed and reinstated without damage.

18.02.25 Reinstatement:

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energised and taken over by the owner. The protective covers shall then be provided, the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required, then temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

In case of the road surface being cement concrete, asphalt or tarred macadam, resurfacing shall be done as per the requirements of the civic authorities.

18.02.26 Jointing Bays:

The successful bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trial pits. The delivery lengths of the cables shall match the location.

The joint bays shall be of sufficient size to accommodate jointing of cables and constructed with RCC M20 Grade and Fe 415 Steel. It shall consist of RCC raft laid over PCC 1:4:8, RCC Retaining walls/Side walls and RCC cover slab with an inspection chamber. All exposed faces of raft, slab and side walls shall be plastered with 12mm thick Cement Mortar 1:4. At the bottom in a corner, a sump pit shall be made for bailing out water.
After completion of all the works, viz., construction of Jointing Bay, laying of cables, testing of cables/jointing etc., the jointing bay shall be backfilled with riddled sand.

The successful bidder shall submit an economical design and drawing of joint bay for approval of the owner.

All works shall be carried out in presence and supervision of the owner's engineer.

18.02.27 Railway Crossing:

The earth shall be excavated using an air compressor with pneumatic drill or equivalent mechanical tool for laying pipes for crossing of railway track after obtaining prior approval of railway authority. The work shall be planned to be completed within shortest possible time. The work shall be carried out as per the standard practice suggested by railway authorities.

18.02.28 Tools and Plant

The successful bidder shall have all necessary tools, plant and equipment to carry out the survey and cable installation work.

The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

18.03.0 JOINTING AND TERMINATING:

18.03.1 Jointing Of Cables

General: The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriageways, driveways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables, and water mains should be avoided wherever possible.

Sufficient over lap of cables, shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed.

The joints of different phases shall be staggered in the jointing bay.

The cable jointing work should be necessarily got done only through well trained professional jointers.

Jointing work details

l) Uncoiling, cleaning, straightening and trimming of 220KV cable as required for jointing.

ii) Checking the cable inside the joint bay before cutting the cable, for any accidental damages due to re-excavation.

iii) Providing the joint tent, tools etc., at the site by the vendor.

iv) Erection of joint tent, (joint tents should be of metallic housing.

v) Electrification of the joint bay, arranging and fixing of air conditioners and maintaining them for the entire period of jointing (temperature inside the joint tents should be maintained below 25 deg C.)

vi) Transporting the required quantity of jointing kits from stores to site (Including link boxes)

vii) Dismantling the wiring, air conditioner etc.

viii) Dismantling the joint tent.

ix) Devolution of cable cut bits to departmental stores including transportation.

x) Providing security guards for joint bay.

xi) Cost of power for the entire period of jointing.

xii) Providing 2 Nos. 2 HP Diesel Dewatering pumps.

18.03.2 Sumpholes:

While jointing cables in water logged ground or under unforeseen rainy conditions, a sumphole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or bailed out by buckets, without causing interference to the jointing operation.

18.03.3 Tents/Covers

Erection of Joint tent (Joint tent shall be of metallic housing) Electrification of Joint bay, arranging and Fixing of Air conditioners and maintaining them for entire period of jointing (Temperature of Joint tent should be maintained below 25 deg. C)

Providing sheath protection for earthing wherever necessary. All accessories and spares required shall be of satisfactory operation for 10 years and furnish the details of maintenance.

18.03.4 Precautions before making a joint:

The cable end seals should not be opened until all necessary precautions

have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable.

If the cable end seals or cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

18.03.04A PERT CHART

Indicating time schedule for supply of cable and accessories and supervision of cable laying, testing and commissioning shall be furnished by successful vendor in consultation with the purchaser and should be got approved along with drum length approval. The schedule should be kept up by the vendor. Any delay in completing the work will attract penalty.

18.03.5 Measurement of Insulation Resistance:

Before jointing, the insulation resistance of both sections of cables shall be checked.

Before laying cable in the ground, the insulation resistance of each section shall be measured.

18.03.6 Identification:

The identification of each phase shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

18.03.7 Making a Joint

Comprehensive jointing instructions should be obtained from the manufacturer of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs, etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

18.03.8 Cable Terminations

The cable terminations used are outdoor type/GIS plugin type.

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures.

The instructions furnished by the termination manufacturer shall be strictly

followed.

At cable terminating end, the following provisions for supply and erections are to be included.

i) A sufficient length of spare cable shall be left in the ground, for future needs

ii) The rise of the cable, immediately from the ground shall be enclosed in minimum dia of 250 mm HDPE pipe to protect against direct exposure to the sun.

iii) The cable shall be properly fastened using nonmetallic clamps.

iv) Appropriate labels shall be fixed identifying the phase, circuit, Voltage and date of commissioning etc., on the cable supporting structure.

v) The sealing ends shall be mounted on pedestal insulators to isolate them from their supporting steel work.

vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.

vii) Providing earth stations with all required materials like leads, connectors, earthing rods/pipes etc.

ACCESSORIES

Dust and humidity free enclosures complete with air conditioners and material handling equipment shall be used by the vendor.

All special tools including a set of jointers hand tools that are necessary to complete the joint/termination works shall be arranged by the vendor. Necessary power supply for jointing and termination works shall be arranged by the vendor.

The cost of consumables which are essential for satisfactory erection and commissioning shall be included.

Adequate quantity of consumable shall be supplied for completing the entire cable laying and jointing works.

Termination Work details:

1) Erection of termination structure.
2) Removal of cable from the trench, rerouting, cleaning straightening and trimming if necessary, checking the exposed cable before cutting the cable for any accidental damages due to re-excavation.

3) Providing of scaffolding pipes, clamps, wooden planks and tools for erection of termination.
4) Erection of scaffolding pipes/ providing crane for lifting 220KV cable and termination.
5) Lifting the cable up the terminal structure and positioning.
6) Transporting the termination kit from departmental stores (including link boxes)
7) Dismantling scaffolding work.
8) Transporting the above item back.
9) Devolution of cable cut bit to departmental stores including transportation.
10) Provision of security guard for the cable end/ termination.
11) Providing fire retardant paint for exposed portion of the cable and other related works.
12) Cost of power for the entire period of work.

18.03.9 Bonding of screen/sheath

The type of bonding i.e., single end bonding/both end bonding/cross bonding as recommended by the successful bidder, shall be adopted.

For one/both end bonding:

The screens at one/both ends, shall be brought out and solidly bonded/ or through SVL to the earth station through disconnecting type link boxes.

The link boxes, single-phase outdoor type with SVL at receiving end (with bye-pass arrangement for SVL) and without SVL at sending end shall be provided.

All accessories and consumables used in the termination should be of good quality and compatible with the cable.

For cross bonding:

Shall be executed as recommended in Clause No.7.04.03.

18.03.10 Connection of Radial Water Barrier and Cable Screen

If the metallic radial water barrier is insulated from the metallic wire screen a connection suitable to carry the currents occurring during operation must be

installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

18.03.11 Erection of Cable Terminating Structure.

The terminating structure should be designed as per the requirement of the cable end sealing, offered by the bidder.

The mounting structure shall have good cement concrete foundation as per civil engineering norms/Approved drawings.

After fixing the end termination, the cable shall be fixed to the support, with nonmagnetic material clamps to the required height securely. The drawings of station structure and equipment for connection of cable will be furnished by the owner.

18.03.12 Surplus Cable

The wastage of cable beyond practically required permissible limits should be avoided.

For any valid reason if there is a surplus cable, it shall be returned to the owner's store.

Approved good quality sealing caps, heat shrinkable type of the correct size, shall be supplied for spare cut lengths of cable exceeding 100 M length, to enable them to be properly stored for future maintenance purposes. The successful bidder shall be responsible for the immediate sealing of such cut lengths and the cost of the sealing end etc., thereof shall be deemed to have been included in the contract price.

The successful bidder shall clean the completed cable route and shall remove all surplus and waste materials, empty cable reels etc., preferably the same day but not later than the next day after the particular work is completed.

18.04.0 CIVIL AND STRUCTURAL WORKS:

General: This specification deals in brief with the civil and structural works for cable laying.

a) The scope of civil works include earth excavation for cable trench & RCC cable duct and cable laying, removal of excavated earth, design, supply and provide plain & reinforced cement concrete for foundations of equipment, support structures, back filling, dewatering of trenches. Design, supply and providing cable jointing bays. The design of RCC cable duct for laying the cable along the route and cable duct/pipe ducts for crossing drains, roads, railway lines etc., shall be suitably done and rates quoted, making provision for complete supplies and erection as per relevant schedules. It includes all connected civil works.

b) Design, fabrication and supply of galvanised steel structures for cable end terminations, mounting of earthing link boxes.

c) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

18.04.1 Codes And Standards

Unless otherwise stated, latest Editions of the following standards are applicable.

IS:1255	:	Installation and Maintenance of Power Cable.
IS:5820	:	Specification for pre-cast concrete cable cover.
IS:209	:	Quality of Zinc for galvanising.
IS:226	:	Structural Steel.
IS:456	:	Plain and Reinforced Cement Concrete.
IS:800	:	Use of structural steel in general building construction.
IS:2016	:	Plain washers.
IS:2633	:	Zinc coating on Galvanised Steel.
IS:3063	:	Spring washers.
IS:5358	:	Hot Dip Galvanised coating on fasteners.
IS:6639	:	Hexagonal Bolts for steel structures.

Any other equivalent International/National Standard.

18.04.2 Excavation

The specification covers excavation for cable trenches, ducts, structural foundations, jointing bays.

The successful bidder shall control the grading in the vicinity of all excavations so that the surface of the ground will be properly sloped or diked to prevent surface water from running into the excavated area during construction.

The excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance to permit the placing,

inspection and setting of forms and completion of all works for which the excavation is done.

The sides and bottoms of excavation shall be cut sharp and true. Under cutting shall not be permitted. Earth sides of excavation shall not be used in lieu of form work for placement of concrete unless authorised by the Engineers of the owner where the limitations of space for large excavation necessitates such decision.

18.04.3 Quantities

The bidder shall indicate the ceiling volumes/quantities for excavation and RCC works and Steel structure works, wherever specifically indicated.

18.04.4 The bidder shall quote unit rates for the items of works. He shall also quote the total price for each of the works.

18.04.5 The quoted price shall also include supply of all material, transportation charges, taxes, duties, octroi and toll, labour, construction plant and equipment and fixtures, fittings and all temporary and permanent works necessary for satisfactory completion in all respects.

18.04.6 The measurements of various civil works shall be jointly recorded; by the successful bidder and the Engineer-in-charge of the owner and duly certified.

18.04.7 When machines are used for excavation the last 300mm. before reaching the required level shall be excavated by hand or by such equipment that will leave the soil at required final level in its natural condition.

18.04.8 The bottom of the excavation shall be trimmed to the required level and when carried below such level by error, shall be brought to level, by filling with lean concrete of 1:4:8 mix, at successful bidder cost.

18.04.9 If the successful bidder is directed by the Engineer-in-charge of the owner to excavate to a lower level than that indicated on the drawing, such additional excavation shall be paid for at the applicable unit rates provided in the tender.

The rates shall be firm irrespective of increase in quantities to any extent. The bidder is bound to carryout any Non-tendered items of work required for completion of the task. For such items of work the applicable KPWD /MWSR schedule of rates, Data rates or derived rates whichever found appropriate will be allowed.

18.04.10 The successful bidder shall be responsible for his estimates, assumptions and conclusions regarding the nature of the materials to be excavated and difficulty of making and maintaining of required excavations and performing the work required as shown on the drawing and in accordance

with these specifications. Cofferdams, sheeting, shoring, bracing, draining, dewatering etc., shall be furnished and installed as required and the cost thereof shall be included in unit rate quoted for the item of excavation. The successful bidder shall be held responsible for any damage to any part of the work and property caused by collapse of sides of excavation. The materials can be salvaged if it can be done with safety for the work and structure and as approved by the Engineering-in-charge.

However, no extra claim shall be entertained for material not salvaged or any other damage to successful bidder property as the results of the collapse. He shall not be entitled to any claim for redoing the excavation as a result of the same.

18.04.11 All excavation for installation of underground facilities shall be open cuts.

18.04.12 The excavation for foundation where specified shall be carried out atleast 75mm. or as specified in relevant drawing below the bottom of the structure concrete and then be brought to the required level by placing lean concrete of 1:4:8 Mix or as specified with aggregate of 40mm. nominal size.

18.04.13 When the excavation requires bracing, sheeting, shoring, or strutting etc., the successful bidder shall submit to the Engineer-in-charge drawings showing arrangement and details of proposed installation and shall obtain the approval from the Engineer-in-charge before proceeding with the work.

18.04.14 The successful bidder shall have to constantly pump out the water collected in the pits, trenches, due to rain, sub-soil, springs etc., and maintain dry working conditions at no extra cost to the owner.

18.04.15 <u>Classification of soil</u>:

For purpose of excavation, the soil is classified as ordinary soil, Hard soil, Ordinary rock and Hard Rock. The details of classifications are given in Annexure - TS-I.

18.04.16 <u>Measurement Of Excavation</u>:

The measurement, for the payment of earth excavation will be based on volume calculations of pit/trench. The unit of measurement shall be cubic meters. Nothing extra would be payable for slopes, shoring, strutting, etc., irrespective of whatever is provided. If directed by the Engineer-in-charge, the excavation shall be done on the slopes from slope stability point of view at no extra cost to the owner.

18.04.17 <u>Carriage of excavated soil beyond a lead of 50 mts per lift of 1.5 mts.</u>

18.04.18 By manual labour:

The excavated earth for disposal purpose beyond 50 mts and upto 300 mts shall be carried by manual labour. If directed by the Engineer-in-charge, this earth shall be used for back filling purpose. The rate for disposal of earth by manual labor upto 300 Mtrs shall be included in the excavation item and no extra rate for the same is admissible.

18.04.19 **By Mechanical Transport:** The successful bidder shall arrange to transport the surplus earth and soft/hard rock, left over after back filling the trench up to the required level (with watering and compaction) and disposal of earth by manual labor, by Mechanical means, to the disposal point of the local bodies with all leads and lifts and as directed by the Engineer-in-charge. It shall however be ensured that no soil is stacked in excavated area. Location where the soil is to be stacked/disposed shall be as directed by the Engineer-in-charge. However the successful bidder shall take all precautions at the site of excavation, for keeping the free flow of vehicular and human traffic and to avoid inconvenience in general.

The soil transported for disposal, shall be stacked and leveled neatly and dressed.

The rate for this item shall include loading, carriage, unloading, stacking and dressing etc., complete.

18.04.20 In no case the excavated soil shall be stacked upto to the distance of 1.5 mts from the edge of excavation or one third the depth of excavation whichever is more.

18.04.21 Lead And Lift:

The rates quoted for all items of work shall include all lifts and leads whenever applicable unless otherwise specified.

18.04.22 Excavation and measurement in Hard Rock:

Blasting in hard rock shall be done as per IS: 4081 (latest Edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Premeasurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

At locations where, open blasting can not be taken up due to site

conditions, controlled blasting or removal of rock by chiseling & wedging shall be resorted to. The rate for excavation of hard rock shall include its removal by all the types referred to, appropriate to the site conditions.

18.04.23 Backfilling Materials:

The backfilling of excavated trenches/RCC cable duct & around foundation shall consist of one of the following materials as the Engineer-in-charge may direct in each location.

i) Selected sieved earth from excavated soil.

ii) Selected sieved earth brought from borrowed area.

iii) Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.

Filling shall be done after the concrete or masonry work has fully set and its curing completed.

The successful bidder shall fill in and around any work untill it has been properly reinstated and approved by the Engineer-in-charge.

18.04.24 Backfilling for cable trench:

Backfilling shall be done in horizontal layers of thickness not exceeding 300mm thickness, free from pockets with careful watering where necessary for compaction. The backfill shall be riddled earth free from materials likely to cause damage to the cables.

The thermal backfill surrounding the cable shall be as per the design approved, by the owner.

18.04.25 Measurements:

Payments for back filling shall be based on the volume of consolidated fill. This volume shall be derived from the difference between the volume of excavation and that of the structure (Concrete work, sand filling), or trench as the case may be.

18.04.26 Specification For Cement Concrete:

For the cement concrete, plain or reinforced for general use, requirement of concrete for nominal mix, strength and quality, pouring at all levels, form

works, protection covering, finishing, add mixtures, inserts, curing etc., the provisions of the latest revision of IS:456 shall be complied with, unless permitted otherwise by any other Indian Standard Codes, shall form the part of the specification to the extent applicable within specification. The cement used shall comply with IS:269. The metal (Jelly) used in PCC/RCC shall be properly graded and machine mixed.

18.04.27 Curing And Protection Of Concrete:

All fresh concrete shall be covered with the layer of an absorbent material and kept constantly wet for a period of seven days or more from the date of placing concrete. The immature concrete shall be protected from the damages and contamination, that would impair the strength of the concrete.

18.04.28 Precast RCC Items:

The concrete mix for the various types of precast units shall conform to IS:456. The aggregate shall be mixed by weight and water cement ratio shall be controlled to obtain the dense concrete and the strength required. The reinforcement shall be as per the design approved. The curing shall be carried out for the period of seven days from the date of casting, and the precast element shall be cured by flooding with water of minimum 25mm. depth over the element for the period mentioned above.

All the precast element shall be marked, appropriately as specified.

18.04.29 Masonry Work:

Stone masonry and Brick (Table mould) masonry work wherever required shall be carried out by the contractor. The associated materials for masonry work like stones, bricks, sand etc., shall be of approved quality. The construction shall comply with accepted norms and standards.

18.04.30 Plaster: Plastering shall be done with cement and sand mortar, 1:4 by volume with clean sand. All plaster work shall comply with IS:1661.

Materials for plaster such as cement, sand, water shall conform to standards.

18.04.31 Mounting Structures:

The mounting structure include the supports for cable end boxes, link boxes and any other structure required for the intent of the contract.

All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust etc., that may impair their strength, durability and appearance. All materials shall be of tested quality only

unless otherwise permitted by the owner. The structures shall be fabricated by the contractor.

18.04.32 Foundation:

Foundations for mounting structures in cement concrete shall be provided as per approved drawings by the Engineer-in-charge.

18.04.33 Bolts Nuts and Washers:

Standard bolts, nuts and washers shall be used in all works. These should be galvanised in accordance with IS:5358.

18.04.34 Painting:

Outdoor Kiosk for link boxes etc., shall be painted with anticorrosive paint and red oxide as primer and two coats of enamel paint. the boxes should be appropriately labelled as per installation at site regarding the Sl. No. location, type caution board/Danger Board. etc.

18.04.35 Materials Used In Cable Laying:

Specification in brief on the materials used in installation of the 220 kV underground cables, like RCC precast cable protection covers, precluded cement concrete blocks for cable route/joint indication, cable and mounting structures, joint bays, earthing and other miscellaneous materials are given below. All materials shall conform to relevant standards, and shall be approved by the Engineer.

18.04.36 RCC Precast Cable Protection Covers:

These should be pre casted as per the approved design and drawing. The reinforced cement concrete should be M20 grade (1:1.5:3 proportion) with 20 mm. and down size coarse aggregate and steel reinforcement (Fe 415 grade) shall be used and cured as per civil Engineering Standards. The covers should carry the legends KPTCL 220 kV CABLES, CKT-1. The covers should be free from burrs and projecting edges so that they may be easily laid to butt. The average breaking load shall be 450 kgs for the cover slabs.

18.04.37 Cable Route Markers/Joint Markers:

Permanent and durable type, cable route markers/ joint indicating blocks should be provided as per the design supplied by the owner.

The cement concrete block should be made by the wet process and the concrete shall consists of one part cement two parts sand four parts aggregate of size 20mm. and down.

The marking block should be given a smooth cover surface of cement

mortar and shall have the appropriate legends, 5mm. deep engraved on them as “KPTCL 220 KV CABLE CKT-1”, “KPTCL 220 KV CABLE JOINT CKT-1”.

18.04.38 Pipes:

HDPE pipes of ISI Mark, 250mm dia and above, 20 mm thickness approximate, of good quality shall be used for formation of cable ducts. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided.

Hume pipes and accessories conforming to IS shall be used if required. Reinforced hume pipe shall not be used for laying single core power cable, in one cable per pipe arrangement.

Stoneware pipes, salt glazed of good and approved quality shall be used.

Hume pipes without steel reinforcement, stoneware pipes, HDPE pipes can also be used where the cable passes through the passage or drive ways of public and private buildings.

In case of pipe – the size of the pipe shall be at least 30 to 40% more than size of cable. The pipe joint shall be done by using proper sleeves so as to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable.

18.04.39 Supporting Structure For Cable And Cable End Terminations:

The bidder shall quote for unit prices for support structure for each single core cable to suit the end termination supplied by him. The bidder shall design and furnish the details and drawings.

These support structures shall be fabricated out of galvanised steel pipe to IS:1239 or they shall be fabricated out of galvanised mild steel sections, such as channels, I-beams etc., conforming to IS:226, pipes if used for fabrication of the structure shall not have any joints.

The height of the structure shall be such that the terminal connection to receive the owner’s ACSR Double Drake/Moose conductor/63 mm. Diameter, IPS aluminium pipe is approximately at a height of 4.5 meters. The successful bidder shall be furnished with relevant drawings by the owner.

18.04.40 The supporting structure shall be suitable to withstand, the wind pressure, seismic forces and the short circuit forces, etc., and the design shall be with an adequate factor of safety as specified in I.E. rules 1956.

18.04.41 The bidder shall furnish the design and fabrication drawings, foundations, foundation anchor bolts, design calculations etc., of these structures.

18.04.42 Terminal Connectors:

The terminal connector/clamps shall be suitable for connection to 63-mm diameter IPS aluminium pipe or double Drake/Moose ACSR conductor. The terminal connector shall be of bimetallic type to connect the terminal of the cable end to the aluminium bus pipe or ACSR conductor.

The type and size of the connector will be confirmed to the successful

bidder. The connector/clamp shall be designed to overcome:

i) Galvanic Corrosion.

ii) Thermal Cycling.

The current carrying capacity of the connector/clamps shall be greater than the maximum capacity of the power cable.

The terminal clamp shall be free from burrs, voids and blowholes.

The terminal clamps shall have passed tests for short circuit current capability and temperature rise.

18.04.43 Sand:

Sand supplied for backfill shall be river sand, free from flakes, dust, earth, organic matter and large pebbles and stones and should be free from any chemical contaminants likely to have corrosive action on the cable coverings.

The sand should be sieved through a mesh to remove all large stones and pebbles. The sand shall be properly graded and shall conform to IS:383 for concreting work.

The owner will decide on the requirement of the use of sand depending on the availability of the excavated earth to be used for backfill.

The sand should be used with the approval of the owner as a backfill.

18.04.44 Earthing:

The earthing system required is for the

i) Earthing of all non-current carrying metal parts and

ii) Earthing system for cable screens/sheath bonding at terminations and at all others places wherever required.

The latest editions of the following standards and codes are applicable.

	IS:3043	Code of practice for earthing.
	IS:2309	Code of practice for the protection of building and allied structures against lightning.
iii)	Indian Electricity Rules 1956	Provision of Rules on EHV systems.
	IEEE-80	Guide for safety in sub-station grounding.

All equipment, supporting and mounting structures of the installation shall be bonded together and connected by separate and distinct conductor to earth electrode.

18.04.45 Earth conductor:

The earth conductor shall be of GI flat, of size 50 x 6 mm. size and shall be protected against mechanical damage and corrosion. The connection of the earth continuity conductors to earth bus and earth electrodes shall be strong, secure and sound and shall be easily accessible.

18.04.46 **Pipe Earth Stations**:

The pipe earth electrodes shall be of cast iron in conformity with IS:3043, buried vertically and the pit filled with alternate layers of charcoal, salt and earth. The earth lead shall be properly fastened with brass bolts nuts and connection shall be enclosed in a masonry chamber. The chamber shall be provided with a RCC inspection cover.

18.04.47 The connection between the earthing terminal of equipment and earth electrode shall be made by short and direct earthing lead, free from kinks and splices.

18.04.48 The distance between any two electrodes shall not be less than, twice the length of the electrode.

18.04.49 All joints shall be covered with suitable compound to protect against corrosion.

18.04.50 Earthing connections with equipment earthing terminals shall be of bolted type. The contact surfaces shall be free from scale, paint, enamels, grease, rust or dirt. Two bolts shall be provided for making each connection. The bolted connections after being checked and tested shall be painted with anticorrosive paint or compound.

18.04.51 Welds and brazed joints shall be treated with red lead and afterwards coated with bitumen compound to prevent corrosion.

18.04.52 Steel to copper connection shall be brazed type and shall be treated to prevent moisture ingress.

18.04.53 The resistance of the welded joint shall not be more than the resistance of equivalent length of the conductor.

18.04.54 All welded joints shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature.

18.04.55 Arc welding with large diameter conductor shall be done with low hydrogen content electrodes.

18.04.56 <u>Bonding Of Cable Screens/Sheath</u>:

Each single phase cable shall have a separate earth for the screen earthing.

The system short circuit level is 50 kA for 1 Sec. The earthing lead at solid earth positions shall be single core, 400 sq.mm copper conductor, PVC insulated 6.6 KV voltage grade Cable.

18.04.57 **<u>Earth Tests</u>**:

Tests on earths shall be carried out by the successful bidder for testing the effectiveness of earth resistance of electrodes and the results furnished to the owner.

19.00.0 TESTING COMMISSIONING, TYPE/ROUTINE TESTS ON CABLES AND ACCESSORIES

19.01.00 General

19.01.01 The material and equipment covered under this contract are subject to strict codes of owner approved Q.A.P., inspection, and tests.

19.01.2 The Engineer or his authorized representative shall have, at all reasonable times access to the contractor's premises to inspect and examine the materials during manufacturer and if part of the equipment is being manufactured or assembled on other premises or works, the bidder shall arrange and obtain permission for the purchaser as if the equipment/material is manufactured at the bidder's own premises. The Owner can depute upto Five Engineers from KPTCL for inspecting the equipments/materials. The Visa to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the contractor.

19.01.3 The inspection requirement for material shall conform to the design, assembly fabrication and tests defined in the reference code of standards.

19.01.4 Approval or passing of any such inspection by the owner, shall not however, prejudice the right of the owner to reject the material or equipment, if it does not comply with the specification when installed and or fails to give the intended service.

19.02.0 Notice of Inspection :

19.02.1 The successful bidder shall give the owner thirty days written notice of any material being ready for inspection and tests.

19.02.2 The Engineer shall, within fifteen days of the inspection, give notice in writing to the successful bidder of any defects noticed during inspection. The successful bidder shall take corrective measures and shall confirm in writing, of the compliance or otherwise, with due reason.

19.02.3 The Engineer shall issue a certificate for having inspected the

material/equipment within thirty days of inspection. The issue of the certificates does not bind the owner to accept the material should it on further tests on installation be found not to comply with the contract specification.

19.02.4 In the case of stage inspection, the successful bidder shall proceed from one stage to another only after the component is inspected by the owner and permission given to proceed further. The same procedure shall apply for any rectification or repairs suggested by the owner.

19.02.5 The owner or the Engineer, shall have the right to inspect any machinery, material, structure, equipment, plant or workmanship, furnished or used by the contractor, and may reject any or all which is defective or unsuitable for the use and purpose intended, or which is not in accordance with the specification.

The successful bidder on demand by the owner shall remedy or replace, at his expense, such defective material/plant equipment. In the event of the failure by the successful bidder for correcting the defect or replacement of the material / equipment plant, the owner may take such remedial measures necessary, at the expense of the contractor.

19.02.6 On the material to be supplied under this contract, it is to be noted that it shall not relieve the successful bidder of his responsibility for supplying material conforming to requirement of the contract, nor prejudice any claim right or privilege which the owner may have because of the use of defective material.

Should the owner waive the inspection, any item of the material, such waiver shall not relive the successful bidder in any way from his obligation under the contract.

In the event of inspection by the engineer, and the inspection revealing goods/materials not in conformity with the standard/specification, the owner shall specify additional tests/inspection procedures, if required, to ascertain compliance with specifications.

19.02.7 A set of latest relevant approved drawings/data/applicable Reference Standards shall be made available to the Engineer during inspection.Standards shall be made available to the Engineer during inspection.

19.03.0 TEST ON MATERIALS SUPPLIED BY SUB-SUCCESSFUL BIDDER:

The plant or equipment supplied by the sub-successful bidder of the successful bidder shall comply in every respect to the specification and applicable tests.

19.04.0 TEST MATERIAL:

The successful bidder shall provide test pieces, as required, in quantity, to determine the quality of material supplied under this contract. If any test piece fails to comply with the requirement the Engineer may reject the whole material represented by the test pieces.

19.05.00 TESTS AT MANUFACTURER'S WORKS:

19.05.01 The test at works shall include the electrical, mechanical and hydraulic and other special tests in accordance with the relevant standards.

A complete test schedule/programme shall be furnished by the contractor.

The successful bidder shall carry out all the tests as specified by the owner, under tests for relevant material.

19.05.02 Test certificate include, test records and performance graphs, drawings, which shall be supplied to the owner. All tests shall be carried out in accordance with the provisions of the contract.

All test certificates must be endorsed with sufficient information to identify the material or equipment to which the certificate refers, and must carry in the top right hand corner the identification of the owner and the contract.

20kV DC voltage test between the metallic sheath and the outer sheath for each and every length of the cable delivered should be conducted and the sheath leakage at 10kV, 15kV and 20kV are to be furnished and got approved before dispatch of cable drums. The leakage current shall be within limits of 5.0mA for 500mtrs at 20kV Dc and 2.0mA for 500mtrs at 10kV DC.

19.05.03 The routine, acceptance and type tests conducted in the presence of the Engineer, and the test certificates shall be approved before the materials are dispatched.

19.06.0 MANUALS & LITERATURE ON MATERIAL/EQUIPMENT

The bidder shall enclose with his offer all literature and manuals relevant to the contract and in particular

i) On cable offered.

ii) On cable jointing and terminating techniques.

iii) Instructions on cable installation, storage, handling, maintenance, fault finding, repairs, preventive maintenance etc.

iv) Literature on special Tools & plant.

v) Literature on sheath bonding, maintenance of link boxes.

vi) Any other relevant literature/manual

19.07.0 TESTS:

19.07.1 The successful bidder shall make available to the Engineer a complete set of detailed data, required for inspection and tests.

19.07.2 Routine & acceptance Tests shall be conducted at the factory by the successful bidder in accordance with the relevant standard code to determine the performance and characteristics of material equipment/ accessory and to determine whether or not the guarantees of quality have been met.

19.07.3 Routine & acceptance Tests shall be conducted in accordance with the relevant IEC-62067: 2011

19.07.4 TYPE TESTS:

The Successful bidder shall indicate that the equipment/material offered has successfully passed the type tests as required by the relevant standard.

Relevant type test certificates shall be furnished along with the bids to prove the quality of the material/equipment including those of the accessories.

The successful bidder shall agree to conduct all tests or repeat the tests already conducted, for the satisfaction of the owner.

19.08.0 ELECTRICAL TESTS AFTER INSTALLATION:

19.08.1 The Successful bidder shall conduct the following tests during and after installation as per IEC 62067: 2011.

19.08.2 In the event of the installation failing the tests, the successful bidder shall at his own expense, identify the cause and rectify the defects, and render the installation serviceable.

19.08.3 DC Voltage Tests of the Over sheath:

a) After the cables have been laid and the trench partly filled and before joints are made a 20KV DC voltage is applied to the over sheath of cable, between the metallic sheath and earth for 15 minutes.

b) The test should be repeated when all the accessories have been installed, before commissioning.

c) The above tests shall be carried out by the vendor in the presence of owners' representative.

d) Should a breakdown of the sheath occur during these tests, the vendor shall locate the fault and repair the cable(s) after owner's agreement until the retests give satisfactory results for the total link.

e) All expenses in connection with the civil works which are made necessary for faults location and repair shall be borne by the vendor including additional costs for the services rendered by the owner

19.08.4 A.C. TESTING:

The installation shall be tested with AC voltage.

(A voltage equal to 1.7 U0 or 180Kv applied for One hour between each conductor and metallic sheath as per Cl. No. 16.3 of IEC-62067: 2011, where U0 is the RMS rated voltage between the conductor and the earth or the metallic sheath. The waveform shall be sinusoidal and the frequency shall be as per Cl. No. 16.3 of IEC-62067.
The installation shall withstand for One hour with the phase to phase voltage applied between the conductor and metallic screen/sheath

OR

Test for 24 hours with the normal operative voltage of the system.

19.08.5 TEST ON NON-METALLIC SHEATH:

The non-metallic sheath shall be subjected to test as per IEC publication 60229.

The bidder can recommend any other test, for satisfactory performance of the installed system.

19.08.6 PRE- COMMISSIONING – ELECTRICAL TESTS AFTER INSTALLATION:

On completion of cable laying, jointing and termination works the complete installation will be tested with.

DC Voltage test on over sheath as above for complete installation.

Sheath fault occurring during laying, testing after laying and during pre-commissioning should be rectified by the vendor free of cost (including civil
works) Necessary sheath repairing kits with heat shrinkable materials are to be supplied as per the site requirement during execution of works.

The following pre-commissioning tests shall be carried out by the VENDOR after installation.

1. Electrostatic capacitance of the cable
2. Resistance of the cable conductor.
3. Resistance of the Sheath.

These tests should be got done by CPRI.

The vendor is requested to quote testing charges.
The owner reserves the right to witness all the tests and the vendor shall provide all facilities to the owner in this regard. The date of testing will be informed by the owner sufficiently in advance to the vendor's supervising engineer, to enable the vendor to carry out the tests.

The vendor should furnish (5 copies) of the test results for calculating the total losses.

The observation period shall be one month of operation after energizing of the cable. For this period of one month the cable circuits will be operated by KPTCL under normal conditions.

If a breakdown occur on the cables or accessories during this period, all repairs shall be made by the vendor at his own expenses including civil works and road cut restoration charges. Owner reserves the right to request to change the full length of cable between the two joints chambers, free of charge including duties and taxes etc., this shall not apply for injuries of external origin.

After the verification is done, field tests shall be carried out again according to site tests specified in the tender clause.

The observation period shall be 3 months of operation after repairs and re-energisation. No breakdown shall occur. If breakdown occurs again on the cable & accessories during this period, all repairs & replacement shall be made by the vendor as given in the above para. When the observation period is completed, the guarantee period will start.

20.00.0 DOCUMENTATION

The following documents should be furnished

a) Along with the bid:

1) Dimensioned cross sectional details of the cable.
2) Current carrying capacities “with supporting calculated data” of the cable and derating factors.
3) Manual of instructions on cable handling and cable laying.
4) Type, acceptance and routine test certificate on the cables as per relevant IS, IEC or other national standards to be furnished by the bidder. For accessories test certificates shall be furnished along with the bid.
5) GA drawing of Dimensioned cross sectional details of the straight through joint kit furnished along with the bill of material.
6) Detailed drawing of the straight through joints to be furnished by the bidder.
7) Type, acceptance and routine test certificate on the straight through joints shall be furnished by the bidder.
8) OGA drawing of the cable end termination furnished along with the offer.
9) Dimensioned cross sectional details of cable end termination with bill of materials to be furnished by the bidder.
10) Manual of instructions on the method and formation of the cable end termination to be furnished by successful bidder.
11) Type, acceptance and routine test certificate on the cable end termination to be furnished by the bidder.
12) OGA drawing of the cable termination structure along with the bill of materials-to be furnished by the bidder.
13) Foundation drawing of the cable terminating structure.
14) Civil Engineering details of jointing bays with cross sectional elevation and plan.
15) Dimensioned cross sectional details and plan of cable trench/duct/road crossing /drain crossing showing the position of cable.
16) Dimensioned cross sectional drawing of the pipe electrode earthing along with bill of materials.
17) Drawing showing the method of bonding of the cable screen/sheath

and the earth connection to be furnished by successful bidder.

18) Drawing of RCC cable protection cover.

19) Calculation of induced voltages in the sheath and the recommended method of bonding.

20) The Successful bidder shall submit 10 sets of cable installation records giving all the details sought by the owner along with the routes map.

b) On award of the contract:

1) The successful bidder shall prepare all relevant and associated drawings of the route layout plan indicating the road crossing, crossing across drains, nallahs, railway lines etc., and location of the straight through joints.

2) The owner will communicate approval to the drawings furnished in respect of the supply as well as for the installation portion within one month from the date of submission.

ANNEXURE - TS 1

CLASSIFICATION OF SOIL STRATA

1.0 Ordinary Soil:

This shall comprise of vegetable or organic soil, turf, sand, sandy soil, silt, loam, clay, mud, red earth, suade, peat, black cotton soil, soft shale, loose murrum, mud debris, concrete below ground level, a mixture of all these and similar material which yields to the ordinary diggingimplement. Removal of gravel or any other modular material having diameter in any one direction not exceeding 75 mm, such occurring strata shall be deemed to be covered under this category.

2.0 Hard soil

This shall include :

(1) Stiff heavy clay, hard shaleor compact murrum requiring digging tool or pick or both and shovel closely applied.

(2) Gravel, soft laterite, kankarand cobble stone having maximum diameter in any one direction between 75 mm and 300 mm.

(3) Soling of road paths, etc., and hard core.

(4) Macadam surfaces such as water bound and bitumen/tar bound.

(5) Lime concrete, stone masonry in lime/cement mortar below ground level.

(6) Soft conglomerate, where the stones may be detached from the matrix with picks.

(7) Generally any material which requires the close application of picks or sacrifices to loosen and not affording resistance to digging greater than hardest of any soil mentioned in item (1) to (6) above.

3.0 Ordinary Rock :

(1) Ordinary rocks comprising of limestone, sand stone, hard laterite, fissured rock, conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars.

(2) Unreinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level.

(3) Boulders, which do not require blasting having maximum diameter in any direction of more than 300 mm found lying loose on the surface or embedded in river bed, soil, talus slope wash and terrace material of dissimilar origin.

NOTE : Hard laterite does not require blasting. It is to be classified under ordinary rock which does not require blasting.

4.0 Hard Rock :

This shall comprise :

(1) Any rock or cement concrete or RCC for the excavation for which the use of mechanical plant or blasting is required.

Hard rock shall be removed by blasting where the same is permitted/allowed. In restricted places hard rock shall be removed by chiseling and wedging/ controlled blasting without causing inconvenience to the free flow of vehicular and human traffic and also without endangering the human life, property etc.

SECTION – DRS

DATA REQUIREMENT SHEETS

(TECHNICAL DATA SHEETS/GUARANTEED TECHNICAL PARTICULARS)

NOTE: Please furnish Technical Data Sheets duly filled in, with each set of Technical bid.

Design, Manufacturer, Testing at works, supply, Civil Engineering works, installation, testing, commissioning of 127/220 kV Single Core, 2000 Sq.mm XLPE underground cable and accessories.

CONTENTS

Sr. No.	DESCRIPTION	ANNEXURE
1	Schedule of Guaranteed Technical Particulars of cable.	Annexure-I
2	Schedule of Guaranteed Technical Particulars of Accessories (Outdoor type termination).	Annexure-II
3	Schedule of Guaranteed Technical Particulars of Normal Straight Joint.	Annexure-III
4	Schedule of Cable Covering Protection units/surge voltage limiters & link box.	Annexure-IV
5	Schedule of Drawings/Graphs	Annexure-V

ANNEXURE-I

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF CABLE

The bidder shall furnish the following information, in addition to any other relevant data, for laying conditions specified, for 127/220 kV E 2000 Sq.mm, Copper, Single Core, XLPE insulated, lead sheathed Cable. The Technical parameters shall be supported with the calculations data sheets.

1	Name of Manufacturer	
2	Country of Manufacturer	
3	Type of Cable/Cable Code	
4	Applicable standard	
5	Voltage a) Rated Nominal Voltage b) Rated Maximum Voltage	
6	Continuous current carrying capacity in Amps (Calculation to be shown separately)	
7	Permissible voltage & frequency variation for satisfactory operation	
8	Suitability for a) Earthed System b) Unearthed system	
9	Type of process of manufacturing of cable (a) Triple Extrusion (Yes/No) (b) Whether VCV method (Yes/No)	
10	Conductor – Construction details a) Nominal Cross section (Sq.mm) b) Material c) Shape d) Diameter of Conductor (mm) e) Number of wires per conductor (Nos.) f) Nominal diameter of wire in conductor (mm)	
11	Conductor screen a) Material and type (extruded) b) Thickness (mm) c) Maximum volume resistivity at 90 $\pm$ 2^0C before and after ageing (ohm-cm)	

12	Maximum value of Electric stress at a) Conductor screen kV/mm b) At the insulation kV/mm (Calculation to be shown separately)	
13	Insulation XLPE a) Curing process (furnish details separately. b) Material/Composition c) Dia over insulation d) Radial thickness i. Nominal (mm) ii. Average (mm) iii. Minimum (mm) iv. tmax-tmin/tmax$\leq$ 0.1 e) Specified insulation resistance at 90^0C f) Insulation resistance at 20^0C	
14	Insulation screen (Non metallic) a) Material & type (extruded) b) Nominal thickness (mm) c) Maximum volume resistivity at 90$\pm$ 2^0C (ohm-cm) d) Maximum dielectric stress (calculation to be provided)	
15	Tape Swellable (Longitudinal Water/Moisture Protection) a) Material b) Thickness c) Tolerance	
16	Radial Water Barrier (lead sheath) a) Type/Composition b) Material c) Nominal Thickness d) Tolerance on Thickness e) Diameter of cable over metallic	

	sheath (mm)	
17	Bedding Tape Over Inner Sheath i) Material ii) Dimension (Wxt) (mm) x (mm) Nom. Min.	

18	Concentric Screen/Armour of Stainless steel/Bronze/Plain Copper Wires) Material) Diameter Nom. (mm) Min. (mm) Whether screen is to be earthed at both ninations (Yes/No) Screen Voltage/KM corresponding to rated ent of cable with one end of screen arthed (Volts). Screen current corresponding to rated current of cable with both ends of screen earthed (Amps)) Screen Loss/KM corresponding to rated current of cable with both ends of screen earthed (Watts) Screen voltage/KM corresponding to short circuit current in cable for 3 phase fault with one end of screen unearthed (Volts) Screen current corresponding to short circuit current in cable for 3 phase fault with both ends of screen earthed (Amps) Current rating of screen under short circuit duty (Amps) Separation between armour wires (mm)	

	Direction of lay Thickness of tape (mm)	
19	Binder Open Helix, Contact Copper Tape Over Screen/Armour Wires Material Dimension (Width x thickness) Nom. (mm) Min. (mm)	
20	Non-woven Water Swellable Tape Over Binder Tape Material Dimension	

21	Overall Sheath i) Material & Type ii) Thickness Nom. (mm) Min. (mm)	
22	Conductive Coating on Outer Sheath a) Material b) Thickness	
23	Anti-termite treatment to outer sheath a) Material	
24	External Overall diameter of Cable	
25	Weight of cable/mtr(Kgs)	
26	Short Circuit rating of conductor 90^0C	

	Operating Temperature for 1 Sec.	
27	a) Minimum Cable Bending Radius (in terms of Cable Diameter) b) Recommended minimum installation radius	
28	Permissible Maximum Tension	
29	Continuous Current Rating Under specified Installation Conditions at Conductor Temperature of 65^0C & 90^0C Ground Temperature 30^0C Thermal resistivity of soil 120-150^0C CM/W Depth of laying 1500 mm Ambient Air Temperature 50^0C No. of Circuits 1 Formation Trefoil touching	Details to be furnished as per the table given below for thermal resistivity of soil of both 120^0C Cm/watt and 150^0C Cm/watt

TABLE

	Single Point/Cross Bonded			**Both End Bonded**		
	65 deg. C Amps	**90 deg. C Amps**		**65 deg. C Amps**	**90 deg. C Amps**	
Current Rating conductor size 2000 sq.mm.						
a) In Ground/Trench						
b) In RCC Duct						

In HDPE (250 mm dia) pipe, **i) one cable per pipe** **ii) Three cable per pipe**					
c) In air					

30	**Maximum Permissible Conductor Temperature for continuous operation under specified installation conditions (^{0}C)**	
31	**Conductor temperature at rated current (^{0}C)**	
32	**Temperature rise for 20% over current**	
33	**Emergency overload rating**	
34	**a) Basic impulse level at conductor temperature of 90^{0}C (kV)** **b) Impulse wave shape**	
35	**Ionisation factor at 50 Hz**	

36	**Power frequency withstand voltage (kV)**	
37	**Tan Delta at 50 Hz (at U_o kV and 90 (-5/+10)^{0}C**	
38	**Sheath voltage at max. load in single point bonded, Trefoil touching formation (V/KM)** **Amps:**	
39	**Withstand voltage of sheath on spark test**	
40	**Permissible short circuit current ratings of conductor** **i) 0.1 Sec KA** **ii) 0.2 Sec KA** **iii) 0.5 Sec KA** **iv) 1.0 Sec KA**	

41	**Short circuit capacity of conductor for one second at 90^{0}C prior to short circuit and 250^{0}C during short circuit (KA)**	
42	**Maximum conductor resistance DC & AC** **a) at 20^{0}C (d.c)/A.C. ohm/KM** **b) at 90^{0}C (d.c)/A.C. ohm/KM** **c) at 105^{0}C (d.c)/A.C. ohm/KM** **(over load temp) a.c. (ohm)** d) at rated continuous current in ground as per Cl. No. 4.00.00 B(i) 10(ii) of Techncial specification (dc)/AC ohm/Km	
43	**Equivalent star resistance at 50 Hz of 3 phase current** **a) at 20^{0}C ohm/KM** **b) at 90^{0}C ohm/KM** **c) at 10% continuous over load temperature (ohm/KM)**	
44	**Star reactance at 50 Hz (ohm/KM)**	
45	**Approximate impedance at 50 Hz per KM** **a) at 20^{0}C ohm/KM** **b) at 90^{0}C ohm/KM** **c) at 10% continuous over load temperature (ohm/KM)**	

46	**Self electrostatic capacitance per phase (Micro farad/KM)**	

47	**Maximum Power factor at Charging KVA of cables when laid direct in ground at normal voltage & frequency** **a) at ambient Temperature** **b) at Maximum Conductor Temperature**	
48	**a) Positive and Negative sequence Impedance (Ohm/Km)** **b) Zero Sequence Impedance (Ohm/KM)**	
49	**Zero Sequence Data** **a) Series Resistance (ohm/Km)** **b) Series Reactance (Ohm/Km)** **c) Shunt Capacitive Reactance (Ohm/Km)**	
50	**a) Sheath Resistance at 20^0C Ohm/Km** **b) Screen Resistance at 20^0C Ohm/Km** **c) Combined Resistance at 20^0C Ohm/Km**	
51	**Sheath voltage under maximum operating conditions, assuming all circuits connected KV per KM**	
52	**Potential gradient at conductor surface KV/Cm** **- Maximum** **- Minimum**	
53	**Surge Impedance of Cable (ohm/km)**	
54	**IR value at ambient Temperature per Km**	
55	**Maximum magnitude of partial discharge at 1.5 Uo.** **At Ambient Temperature (Pc)** **At High Temperature (PC)**	
56	**Guaranteed losses per Km (Calculation sheet to be**	

	furnished) **For details such as current rating, AC resistance to be considered etc., Refer Guaranteed losses clause no.10.09 of technical specification & respective clause of SCC of bid documnts**	
57	**a) Dielectric Loss per phase at rated voltage and rated current** **b) Copper Loss per phase at rated voltage and rated current.** **c) Sheath / screen loss per phase at rated voltage & rated current.** **d) Other losses due to reinforcement** **e) Total Losses at rated continuous current** **Charging Current at rated Voltage per Km (Amps)**	
58	**Circulating Currents Under BEB Condition in** **Lead** **i. Sheath Amps:** **ii. Copper Wire Screen Amps:** **iii. In Both Amps:** **When current in conductor is 1250A**	
59	**Circulating current in lead sheath armouring / Cu screen (when the conductor is carrying 50 KA S.C. Current) KA**	
60	**Combined Short Circuit Capacity of Metallic Sheath and Screen for 1 Sec, at metallic sheath / screen temperature of 75^0C (conductor temperature 90^0C before S.C. & 250^0C during S.C)** **KA**	
61	**Screening factor of cable for calculating interference on control and communication cables:**	

62	**Approximate Value of attenuation of carrier current signals operating over a frequency range** **i. 50 KC/s - dB/KM** **ii. 100 KC/s - dB/KM** **iii. 150 KC/s - dB/KM** **iv. 200 KC/s - dB/KM**	
63	**Shipping Weight and size of cable drum.** **a) Size of Drum** **i. Dia of Drum(M)** **ii. Width of Drum(M)** **iii. Gross Weight(Kgs)** **iv. Length of Cable Per drum(M)** **v. Weight of Cable(Kg/M)** **. Weight of copper (Main conductor excluding copper wire screen) (Kg/M)** **Weight of copper (Copper wire screen excluding main main conductor(Kg/M)** **viii. Weight of lead(Kg/M)**	
64	**Guaranteed maximum life in years**	

TABLE - II

65. DERATING FACTORS

a) VARIATION IN GROUND TEMPERATURE:

Ground Temperature	**:**	**15**	**20**	**25**	**30**	**35**	**40**	**45**
Rating Factor	**:**							

b) VARIATION IN DEPTH OF LAYING:

Depth of Laying (Meters)	**:0.7**	**0.9**	**1.0**	**1.2**	**1.3**	**1.35**	**1.5**	**1.8**

Rating Factor :

c) VARIATION IN THERMAL RESISTIVITY OF SOIL:

Thermal Resistivity of Soil: 100 120 150 200 250
(^{0}C cm/watt)

Rating Factor :

d) VARIATION IN AIR TEMPERATURE:

Air Temperature (^{0}C) : 25 30 35 40 45 50 55

Rating Factor :

e) VARIATION DISTANCE (mm):

Axial Distance (mm) : 100 200 300 400 600 800
Between Circuits

Rating Factor :

ANNEXURE-II

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR ACCESSORIES

Outdoor Type Cable end Termination (Sealing End)/ Plugin type for GIS Modules

1.	**Manufacturer's Name**	**:**
2.	**Country of Manufacture**	**:**
3.	**Class and Type**	**:**
4.	**No. of years the design in commercial use**	**:**
5.	**Rated Voltage Kv**	**:**
6.	**Rated Continuous Current Amps**	**:**
7.	**Size of sealing end termination**	**:**
8.	**Total Creepage Distance (mm)**	**:**
9.	**Maximum Conductor Size, Cu (Sq.mm)**	**:**
10.	**Details of Terminal Connector**	**:**
11.	**Power Frequency Voltage 1 Min Dry withstand : Test kV. rms**	
12.	**Power Frequency Voltage Wet withstand Voltage kV** **Time: Sec.**	**:**
13.	**Power Frequency Voltage Dry withstand Voltage kV. rms**	**:**
14.	**Flashover voltage** **Dry KV rms** **Wet KV rms**	**:**
15.	**Radio Interference Voltage (R.I.V.) Test (Micro Volts)**	**:**
16.	**Partial Discharge (corona) extinction Test**	**:**

a) Extinction Voltage kV rms :

b) Minimum Detector Sensitivity PC :

17. Impulse Voltage Lightning Voltage Dry Withstand kV (Crest) :

18. Direct Voltage 15 Min Dry withstand kV :

19. Description of Materials Used in the terminations with electrical & mechanical Particulars :

20. Mounting Structure Details for termination :

21. Electrical & Mechanical Particulars of

a) Heat Shrinkable Tubing :

b) Heat Shrinkable Moulded Parts :

c) Heat Shrinkable adhesives/sealents :

22. Type Tested to [Standard (s)] :

23. Other Details :

Please Enclose complete Technical literature :

ANNEXURE-III

Normal Straight Joint (Earthing Type) And (Straight Joint Insulated)

1.	Name of Manufacturer		:
2.	Country of Manufacture		:
3.	Type (Design) of Joint		:
4.	No. of years the design is in commercial use		:
5.	Rated Voltage	kV	:
6.	Rated Current	Amps	:
7.	Suitable for cable Conductor	Sq.mm	:
8.	Connector, Type, Material		:
9.	Partial discharge test 245 kV	PC	:
10.	A.C. Withstand Voltage	kV	:
11.	Impulse withstand voltage +ve& -ve 10 times kV		:
12.	Load Cycling 90^0C + 5^0C (No. of Cycles)		:
13.	Load Cycling as above under Water at -----KV	(No. of Cycles)	:
14.	D.C. Withstand ----- kV	Hrs	:
15.	D.C. Withstand Voltage 15 Min		:
16.	Conductor thermal short circuit 250^0C For 1 Sec		:
17.	Shield thermal short circuit 250^0C for 1 Sec		:
18.	Type Tested to Standard (S)		:
19.	Maximum conductor temperature in joint at rated current.		
20.	Additional Information		:

ANNEXURE-IV

I. Cable Covering Protection Units / Surge Voltage Limiters:

1.	Manufacturer's Name		:
2.	Country of manufacture		:
3.	Type of Material		:
4.	Dimensions / Weight	mm/Kg	:
5.	Rated Voltage	Kv	:
6.	Characteristics		:
7.	Nominal discharge current KA		:
8.	Power frequency withstand voltage KV		:
9.	Power frequency spark over voltage kV		:
10.	Reseal voltage		:
11.	Pressure relief class		:
12.	Impulse high current short duration Discharge (Amps)		:
13.	Additional Requirements		:

II. Link box details and other accessories:

S. No.	Technical Particulars
1.	Details of Link Box
a)	Material.
b)	Type of Application
c)	Drawings
d)	Accessibility
e)	Suitability
f)	At Circuit end
g)	Option
h)	Special arrangement
i)	Accessories
2.	Cross-bonding Link Box (CBB) Concentric bonding leads of suitable size to suit 3 Nos of

Co-axial cable entries to CBB

3. **Sheath Bonding Cables**
4. **Cross Bonding of Cable Sheath**
5. **No Of Joints**
6. **Sheath standing voltage to earth for rated cable current**
7. **Sheath standing voltage to earth when an external 13-symmetrical through fault**
8. **Transposition of cables: No. of Cable Transpositions and other details.**
9. **Details of Distributed Temperature Sensing (DTS) system such as make, No. of Channels, Distance covered, components of Hardware, List of Softwares, Industrial PC, DTS Cofigurator, Protocol adopted, applicable standards etc.**

III. List of consumables to be supplied by the vendor

Sl. No.	Description	Quantity

ANNEXURE – V

SCHEDULE OF DRAWINGS/GRAPHS

The bidder shall furnish the following drawings along with the graph.

Sl. No.	Description	
1	Cross section and dimensional drawings of the cable with weight	
2	Detailed drawings of the straight through joint.	
3	Detailed drawings of the direct earthing link boxes. a) Weather proof type b) Structure mounted type	
4	Detailed drawings of sheath earthing link boxes weather proof type	
5	Detailed drawing of the cable earthing arrangement	
6	Detailed drawing of the cable protection unit (S.V.L)	
7	Outline dimensional and assembly drawings of cable sealing end.	
8	Outline dimensional and assembly drawings of a) Normal straight joint	
9	Detailed drawings of cable termination supporting structure and foundation.	
10	Schematic drawings of cables installation Cable screen earthed at both ends. Installation of cables in trench(direct buried) Installation of cables in RCC ducts Installation of cables in RCC through/over open drains Installation of cables in pipes Plan and cross sectional drawings of cable jointing bay in detail, with transposition of cable with cross bonding of cables. Plan and cross sectional drawings of cable jointing bay in detail, without transposition of cable with cross bonding of cables.	
11	Detailed drawing of RCC cable protection Covers.	
12	Detailed drawing of cable reel/drum.	

13	**Characteristics of cable temperature Vs current**	
14	**Characteristics of cable and sealing end-power factor Vs temperature.**	
15	**Characteristics of cable and sealing end-power factor Vs voltage.**	
16	**Characteristics of cable and sealing end-partial discharge magnitude v/s temperature.**	
17	**Characteristics of cable covering protection unit (S.V.L)**	
18	**Foundation drawing of** **Cable end termination structure** **Special link box mounting structure**	
19	**Arrangement of joint chamber with dimensions**	
20	**Arrangement of terminal structure for outdoor sealing end with civil designs with earthing arrangement cable**	
21	**Cross section of sheath bonding cable**	
22	**Drawing of straight rollers and angle rollers**	
23	**Trefoil clamp**	

ANNEXURE-VI

Schedule of instruction manuals/catalogues/calculations/certificates etc.

Sl. No.	Description	Quantity
1	Description of extrusion, curing and cooling processes	
2	Transport, storage and handling practices for cables and accessories	
3	Electrical characteristics (conductor resistance, capacitance, electrical stress etc.) of the cables	
4	Characteristics of sheath voltage limiters and surge arresters	
5	Manning schedule for one set of three straight through joints and one set of three sealing ends	
6	Design calculations – wherever called for against respective clause of specification and GTP	
7	Type test certificates issued by a recognised institution	

NOTE: Not exhaustive. Bidders may furnish additional documents as required.

ANNEXURE-VII

1) Schedule of tests and charges for tests

Sl. No.	DETAILS OF TEST	CHARGES PER TEST
I-A	Type Tests	
B	Routine Test	
C	Site Tests	
D	Special Tests (Specified)	
E	Other tests at works/Site Recommended by the tenderer	
II	Total cost towards inspections and tests (special routine and acceptance tests) included in the price bid (if chargeable to owner) (break-up details to be furnished separately)	
	Note: Details have to be furnished for tests on cables as well as accessories, each separately.	

ANNEXURE-VIII

Test Data on the 220 KV XLPE cable and accessories

Sl. No.	DETAILS REQUIRED		STANDARDS AS PER WHICH TESTED	DATA/TEST RESULTS TO BE FURNISHED
1	**FOR IMPULSE TEST (HOT CONDITIONS):**			
	i.	Number of samples tested		
	ii.	Cable cross section and insulation wall thickness		
	iii.	Type of terminations		
	iv.	Type of joints		
	v.	Basic impulse level (wave form and peak voltage)		
	vi.	Breakdown level		
2	**FOR POWER FREQUENCY TEST (COLD/HOT CONDITIONS):**			
	i.	Number of samples tested		
	ii.	Cable cross section and insulation wall thickness		
	iii.	Type of terminations		
	iv.	Type of joints		
	v.	Voltage applied and duration		
	vi.	Breakdown level		
3	**FOR LONG TERM TESTS:**			
	i.	Length of the cable loop		
	ii.	Cable cross section and insulation wall thickness		
	iii.	Number and type of terminations & joints		
	iv.	Installation conditions (air, buried)		
	v.	Voltage applied and duration		
	vi.	Conductor temperature at the end of heating cycle		
	vii.	Breakdown conditions (if any)		

NOTE: Details should be furnished for each and every sample for item (1) and (2) and for each and every long term test for item (3).

ANNEXURE-IX

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SCHEDULE OF DOMESTIC VALUE ADDED COMPONENTS

Sl. No.	ITEM	QUANTITY (EX-WORKS)	UNIT PRICE (EX-WORKS)	TOTAL PRICE
	Total Ex-works bid price (X)			

Total Ex-works bid price (X) =

Domestic value added component =

Domestic value added component =

(as percentage of total Ex-works bid price)

*** To be furnished for each category separately**

SECTION – DRS

DATA REQUIREMENT SHEETS

ANNEXURE TS-II

Turnkey Package for supply, installation of 220 KV cables with all associated accessories and materials at various locations in Bangalore City.

S.No.	Description	Drawing No.
1	Proposed Cable Route	Uploaded in the Website
2	Single Line Diagram	Uploaded in the Website
3	Sheath Bonding System	
4	Cable Construction	
5	Cable Trench	
6	Cable Trench for Road Crossing	
7	Cable Duct	
8	Precast RCC Tile	
9	Reinforcement Details of Precast RCC tile	
10	Cable Route/Joint Marker	
11	Pipe Earthing	

ANNEXURE-I

PROCEDURE AND SPECIFICATION TO BE FOLLOWED BY UTILITY AGENCIES FOR RESTORATION OF FOOTPATH

1 Removing footpath slabs if any and stacking at a designated place with all lead and lifts of 50 mtrs. and Earth work excavation for leveling and lowering the footpath to the required depth and slope, as directed. Removal of roots and other organic materials including consolidation with watering to get the required density to the satisfaction of BMP Engineer incharge of work.

2 Providing polythene sheet of 300 micron thick over the prepared surface adequately stiffened to prevent distortion during handling in order to prevent the slurry entering the sub soil.

3 Refixing the stone slabs longitudinally at the outer edge with a projection of 2.00 cms. above the concrete surface and cutting the edges to regular shape and with pointing in CM 1:3.

4 Removing and refixing in position available Kerb stones of granite, dressing the top surface and neatly rounding of the edges and fixing in ground with excavation to the required depth in all soils and pointing in CM:1:3 and providing painting to kerb stones with Black and yellow Japan paint alternatively and as directed by BMP Engineer incharge of work.

5 Providing and fixing precast fiber reinforced semicircular shoulder drains of 0.60 m. dia in CC M20 grade with necessary earth work at an interval of 30mtrs. or less as per site conditions including fixing, laying, curing, with all lead and lifts etc., complete as per the direction of Engineer incharge and providing and fixing recast RCC covering slab of 100 mm thick over shoulder drain flushing with concrete surface.

6 Formation of footpath surface to a width of 0.450mtr. at an interval of 30mtrs. and covered with precast covering slab of 10 cms thick in blend with RMC concrete to facilitate drawing of underground cable whenever necessary.

7 Providing necessary catch drain in front of shoulder drains, of size 0.23 x 0.60 x 0.40 mtr. clear with necessary grating over catch drain with one end of the grating fixed with hinges for easy operation.

8 Providing CI/ precast grating at the mouth of the shoulder drain and suitably and firmly fixed with the kerb.

9 Supplying and fixing necessary edge stones or suitable protective measures around to the existing trees/poles etc.

10 Providing and laying 100mm thick ready mixed cement concrete M25 over the prepared surface covered with polythin sheet using 20mm and down size granite jelly with necessary form work including vibrating groom finishing and curing etc., with all

lead and lifts etc., complete to a width of 2 mtrs with proper expansion joints at an interval of 6 mtrs etc., complete as per drawing.

11 Restoration of road cross cuttings to be done by refilling the excavated trench with available soil in layers of 15 cms. With watering and compacting, over which to be filled with good quality of sand to a minimum depth of 0.30 mtr and the top surface to be provided with 20 Cm thick ready mixed cement concrete (RMC) of M25 grade to the full width of the trench, including vibrating, compacting, curing etc., complete with all leads and lifts and in level with the existing road surface.

12 Providing mountable kerb to the approaches wherever necessary with necessary pointing and painting.

13 Conveying the surplus earth, debris or any other unwanted loose materials at the works spot to the designated dumping yard with all leads and lift as directed by BMP, Engineer incharge of the work.

GUARANTEED LOSSES:

i) The bidder shall clearly indicate the guaranteed value of the losses (at a maximum of two decimal places only) which **shall be firm and without any tolerance limit** in respect of under mentioned types of losses, as required in Schedule-14 at rated current, voltage & frequency **per circuit KM (all 3 phases put together in one KM length of cable) in KW only**.

(a) Dielectric losses
(b) Conductor/Copper losses.
(c) Sheath losses.

ii) The Guaranteed values of these losses quoted by the bidder will be taken for capitalizing the losses at the rates indicated below wherein the quoted prices shall be loaded by the differential capitalized loss amount for the purpose of bid comparison. For fraction of a KW quoted, capitalized cost of losses shall be calculated on pro-rata basis.

1	Capitalized Cost of Dielectric Losses	**Rs. 4,53,000/- per KW.**
2	Capitalized Cost for Conductor/Copper loss and sheath loss.	**Rs. 1,85,000/- per KW.**

iii) For the purpose of evaluation of the offer, the lowest individual losses/CKM quoted for each type of losses by any bidder shall be taken as the basis to work out the deviation in quoted losses by any particular bidder. No rounding-off of any value will be done and Loss values will be reckoned up to TWO decimal places only. The bid price would then be enhanced by the differential capitalized amount for the purpose of comparison of bids.

iv) The cable losses guaranteed in the bid are to be supported by design calculations along with documentary evidences if any, as per procedure & formula stipulated in IEC 60287-1-1 with latest amendments thereof. The reference of the same along with an extract of applicable IEC Standard shall be clearly furnished along with the GTP.

v) The value of loss factor of the XLPE insulation (tan δ) shall be as per IEC 60287-1-1 i.e., 0.001. This value shall be taken for calculation of dielectric losses/evaluation. No upper tolerance limit would be allowed for this value. However bidder can supply cables of tan delta values lesser than 0.001

vi) The current in the conductor (I), for computation of conductor/copper loss shall be the rated continuous current in ground, as per clause no. 4.00.00 BI (11) (ii) of Technical specification of cable. The AC resistance of conductor (R_{ac}), at the **said rated continuous current in ground** shall be considered for calculation of copper losses. All cable parameters considered for loss calculation shall be as per the values declared by the bidder in the GTP. Any assumptions/ Omissions in the Formula used for detailed loss calculation as per the above IEC shall be invariably indicated in the GTP.

vii) In case the declared guaranteed/quoted losses are in deviation to the losses arrived as per calculation, the higher of the two would be considered for evaluation of the offer and the lower of the losses would be considered for acceptance of the cable.

viii) On testing, if it is found that actual losses are more than the values guaranteed/quoted in Schedule-14, penalty shall be recovered from the bidder at the rates ***triple the capitalisation cost*** indicated under sl. no. (ii) above. However, no incentive would be allowed if the actual losses are found to be less than the guaranteed/quoted values.

ix) The cable would be accepted only if the measured values/test values/actual values on the finished product (on testing) is found to be within +5% of the guaranteed/quoted values for each type of losses subject to recovery of penalty as stated in sl. no (viii) above. In case the measured value is exceeding the limit of 5% in any type of these losses, the cable would be out rightly rejected.

x) The guaranteed values of the losses quoted by the successful bidder will be verified at the time of final acceptance of the material after conducting necessary Tests on a random sample/s of the material taken from the finished product. The Tests shall be conducted in the laboratories as per terms and conditions as noted elsewhere in the tender documents.

SPECIFIC TECHNICAL REQUIREMENTS FOR COMMUNICATION

The communication requirement shall be in accordance to CEA (Technical Standards for Communication System in Power System Operations) Regulations, 2020, CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022, CERC (Communication System for inter-State transmission of electricity) Regulations, 2017, CEA (Cyber Security in Power Sector) Guidelines, 2021, and CERC Guidelines on "Interface Requirements" 2024, all above documents as amended from time to time.

The complete InSTS communication system commissioned by TSP under the RFP shall be the asset of InSTS and shall be available for usage of InSTS requirements as suggested by STU from time to time.

The communication services viz. SCADA, VoIP, PMU, AGC & AMR (wherever applicable) have been identified as critical services and therefore shall be provisioned with 2+2 redundancy i.e. 2 channels for Main Control Centre (SLDC) and 2 channels for Backup Control Centre (SLDC). In order to meet this requirement, suitable redundancy at port and card level need to be ensured by the TSP to avoid any single point of failure which may lead to interruption in real-time grid operation.

PMU to PDC communication (wherever required) shall be through 2 channels to the PDC (main) as there is no backup PDC at present.

Accordingly, all the hardware for communication services of station as stated above shall support dual redundancy for data transmission of station to respective main and backup SLDC.

In order to meet the requirement for grid management and operation of substations, Transmission Service Provider (TSP) shall provide the following**:**

C.1.0 400kV DC Quad moose line from proposed 400kV Ryapte Substation to proposed 400kV Doddathagalli Substation (Quad ACSR/ AAAC/ AL59 Moose equivalent).

On 400kV D/C line from 400kV Ryapte to 400kV Doddathagalli, TSP shall supply, install & commission One (1) No. OPGW cable containing 48 Fibres (48F) on one E/W peak and conventional earth wire on other E/W peak.

The TSP shall install this OPGW from gantry of Ryapte up to the gantry of Doddathaggalli (Near Hoskote) with all associated hardware including Vibration Dampers, mid-way & gantry Joint Boxes (called OPGW Hardware hereafter) and finally terminate in Joint Boxes at end Substations. The transmission line length is 135kms (approx.).

Maintenance of OPGW Cable, OPGW Hardware & shall be the responsibility of TSP.

C.2.0 2Nos. of 400 kV line bays line bays at 400/220kV Ryapte for termination of 400kV Doddattaggalli DC lines.

I. TSP shall supply, install & commission one or more no. FODP (336F or higher) along with panel and required Approach Cables (48F/24F) with all associated hardware fittings from gantry tower to Bay Kiosk and from the Bay Kiosk to Control room.

II. TSP shall supply, install & commission One or more STM-16 (FOTE) equipment along with panel/s supporting minimum **Nine (9)** directions with Multiplex Section Protection – 1+1 (MSP)with necessary interfaces to meet the voice and data communication requirement among proposed 400kV Doddataggalli S/s. These directions shall exclude protected (1+1) local patching among equipment (if any). The suitable DC Power Supply and backup to be provided for communication equipment. The 8command Digital Tele Protection Coupler (DTPC) with 220V DC source on E1 for each 400kV line at both ends to be provided.

III. FOTE/FODP panel shall be installed in the new Bay Kiosk/ Switchyard Panel Room (SPR). The FOTE under present scope shall be integrated by TSP with the existing FOTE at remote end Sub-stations ie., 400kV Doddataggalli which shall be communicating with respective control center. TSP to provide necessary FODP sub rack / Splice trays/ Patch cords etc. and optical interfaces/equipment in the existing FOTE/FODP panels for integration with the existing FOTE for onwards data transmission.

In case spare optical direction is not available in the existing FOTE the TSP shall coordinate with station owner to reconfigure the directions in existing FOTE at control room. Alternatively, The TSP may integrate the FOTE under the present scope with existing FOTE in the nearby Kiosk connected to the control room FOTE (if available with spare direction). For this purpose, TSP shall provide necessary FODP sub rack / Splice trays/ Patch cords etc. and suitable optical interfaces/ equipment in the existing FOTE/FODP panels in another Kiosk (SPR).

IV. FOTE & FODP can be accommodated in same panel to optimize space.

V. The new communication equipment under the present scope shall be compatible for integration with existing KPTCL NMS of OPGW. The local

configuration of the new communication equipment shall be the responsibility of TSP. The configuration work in the existing centralized NMS for integration of new Communication equipment shall be done by KPTCL Team, however all the necessary support in this regard shall be ensured by TSP.

The maintenance of all the communication equipment and software thereof including FOTE, PMU, FODP, approach cable, DCPS along with Battery Bank shall be the responsibility of TSP.

Further necessary optical interfaces shall also be provided by the TSP in the FOTE of 400kV Doddataggalli S/s as per link budget requirement.

C.3.0 400kV DC Quad moose line from proposed 400kV Doddathaggalli Substation to existing 400kVKolar substation (Quad ACSR/ AAAC/ AL59 Moose equivalent).

On 400 kV D/C line from 400kV Doddatahagalli to 400kV Kolar, TSP shall supply, install & commission One (1) No. OPGW cable containing 48 Fibres (48F) on one E/W peak and conventional earth wire on other E/W peak.

The TSP shall install this OPGW from gantry of Doddathaggalli up to the gantry of Kolar with all associated hardware including Vibration Dampers, mid-way & gantry Joint Boxes (called OPGW Hardware hereafter) and finally terminate in Joint Boxes at end Substations. The transmission line length is 140kms (approx.).

Maintenance of OPGW Cable, OPGW Hardware & accessories shall be the responsibility of TSP.

C.4.0 4Nos. of 400 kV line bays line bays at 400/220kV Doddataggalli for termination of 400kV Kolar and 400 kV Ryapte DC lines.

I. TSP shall supply, install & commission one or more no. FODP (336F or higher) along with panel and required Approach Cables (48F/24F) with all associated hardware fittings from gantry tower to Bay Kiosk and from the Bay Kiosk to Control room.

II. TSP shall supply, install & commission One or more STM-16 (FOTE) equipment along with panel/s supporting minimum **Nine (9)** directions with Multiplex Section Protection – 1+1 (MSP)with necessary interfaces to meet the voice and data communication requirement among proposed

400kV Ryapte and existing 400kV Kolar S/s. These directions shall exclude protected (1+1) local patching among equipment (if any). The suitable DC Power Supply and backup to be provided for communication equipment. The 8command Digital Tele Protection Coupler (DTPC) with 220V DC source on E1 for each 400kV line at both ends to be provided.

III. FOTE/FODP panel shall be installed in the new Bay Kiosk/ Switchyard Panel Room (SPR). The FOTE under present scope shall be integrated by TSP with the existing FOTE at remote end Sub-stations ie., 400kV Kolar and 400kV Ryapte which shall be communicating with respective control center. TSP to provide necessary FODP sub rack / Splice trays/ Patch cords etc. and optical interfaces/equipment in the existing FOTE/FODP panels for integration with the existing FOTE for onwards data transmission.

In case spare optical direction is not available in the existing FOTE the TSP shall coordinate with station owner to reconfigure the directions in existing FOTE at control room. Alternatively, The TSP may integrate the FOTE under the present scope with existing FOTE in the nearby Kiosk connected to the control room FOTE (if available with spare direction). For this purpose, TSP shall provide necessary FODP sub rack / Splice trays/ Patch cords etc. and suitable optical interfaces/ equipment in the existing FOTE/FODP panels in another Kiosk (SPR).

IV. FOTE & FODP can be accommodated in same panel to optimize space.

V. The new communication equipment under the present scope shall be compatible for integration with existing KPTCL NMS of OPGW. The local configuration of the new communication equipment shall be the responsibility of TSP. The configuration work in the existing centralized NMS for integration of new Communication equipment shall be done by KPTCL Team, however all the necessary support in this regard shall be ensured by TSP.

The maintenance of all the communication equipment and software thereof including FOTE, PMU, FODP, approach cable, DCPS along with Battery Bank shall be the responsibility of TSP.

Further necessary optical interfaces shall also be provided by the TSP in the FOTE of 400kV Kolar and 400kV Ryapte S/s as per link budget requirement.

C.5.0 220kV line bays at 400/220kV Doddathaggalli for termination of proposed 220 kV Sarjapura lines along with 2Nos of 220kV TB's at Sarjapura.

On 220kV line from proposed 400/220kV Doddatahaggalli to 220kV Sarjapura Sub-station, TSP shall supply, install and commission OPGW as per Tower Configurations:

(I) DC line on Single Towers: One (1) no. OPGW cable containing 48Fibres (48F) to be installed and commissioned by the TSP.
(II) Along with UG cable,48F UGOFC with accessories has to be laid in HDPE pipe.

The TSP shall install OPGW cables from Sarjapura S/s up to gantry of 400kV Doddathaggalli with all associated hardware including Vibration Dampers, mid-way and gantry Joint Boxes (called OPGW Hardware hereafter) and finally terminate in Joint Boxes at 400kV Doddathaggalli sub-station and 220kV Sarjapura sub-stations.

Further TSP shall comply to the requirements mentioned as per **Appendix-F.1-VOID**

Maintenance of OPGW Cable and OPGW Hardware shall be responsibility of TSP.

C.6.0 220kV line bays at 400/220kV Doddathaggalli for termination of proposed 220 kV Malur lines along with 2Nos of 220kV TB's at Malur.

On 220kV line from proposed 400/220kV Doddatahaggalli to 220kV Malur Sub-station, TSP shall supply, install and commission OPGW as per Tower Configurations:

(I) DC line on Single Towers: One (1) no. OPGW cable containing 48Fibres (48F) to be installed and commissioned by the TSP

The TSP shall install OPGW cables from gantry of IPP sub-station up to gantry of 400kV Doddathaggalli with all associated hardware including Vibration Dampers, mid-way and gantry Joint Boxes (called OPGW Hardware hereafter) and finally terminate in Joint Boxes at 400kV Doddathaggalli sub-station and 220kV Malur sub-stations.

Further TSP shall comply to the requirements mentioned as per **Appendix-F.1-VOID**

Maintenance of OPGW Cable and OPGW Hardware shall be responsibility of TSP.

C.7.0 220kV line bays at 400/220kV Doddathaggalli for termination of proposed 220 kV Ekrajapura lines along with 2Nos of 220kV TB's at Ekrajapura SS.

On 220kV line from proposed 400/220kV Doddatahaggalli to 220kV Ekrajapura Sub-station, TSP shall supply, install and commission OPGW as per Tower Configurations:

(I) DC line on Single Towers: One (1) no. OPGW cable containing 48Fibres (48F) to be installed and commissioned by the TSP.
(II) Along with UG cable,48F UGOFC with accessories has to be laid in HDPE pipe.

The TSP shall install OPGW cables from gantry of IPP sub-station up to gantry of 400kV Doddathaggalli with all associated hardware including Vibration Dampers, mid-way and gantry Joint Boxes (called OPGW Hardware hereafter) and finally terminate in Joint Boxes at 400kV Doddathaggalli sub-station and 220kV Erajapura sub-stations.

Further TSP shall comply to the requirements mentioned as per **Appendix-F.1-VOID**

Maintenance of OPGW Cable and OPGW Hardware shall be responsibility of TSP.

C.8.0 220kV line bays at 400/220kV Doddathaggalli for termination of proposed 220 kV Hoskote_New lines along with 2Nos of 220kV TB's at Hoskote_New SS.

On 220kV line from proposed 400/220kV Doddatahaggalli to 220kV Hoskote Sub-station, TSP shall supply, install and commission OPGW as per Tower Configurations:

(I) DC line on Single Towers: One (1) no. OPGW cable containing 48Fibres (48F) to be installed and commissioned by the TSP.
(II) Along with UG cable,48F UGOFC with accessories has to be laid in HDPE pipe.

The TSP shall install OPGW cables from gantry of Hoskote_new S/S up to gantry of 400kV Doddathaggalli with all associated hardware including Vibration Dampers, mid-way and gantry Joint Boxes (called OPGW Hardware hereafter) and finally terminate in Joint Boxes at 400kV Doddathaggalli sub-station and 220kV Hoskote_New sub-stations.

Further TSP shall comply to the requirements mentioned as per **Appendix-F.1-VOID**

Maintenance of OPGW Cable and OPGW Hardware shall be responsibility of TSP.

C.9.0 8Nos. of 220kV line bays at 400/220kV Doddathaggalli for termination of proposed 220 kV DC lines.

I. TSP shall supply, install & commission one or more no. FODP (432F or higher) along with panel and required Approach Cables (48F/24F) with all associated hardware fittings from gantry tower to Bay Kiosk and from the Bay Kiosk to Control room.

II. TSP shall supply, install & commission One or more STM-16 (FOTE) equipment along with panel/s supporting minimum **Nine (9)** directions with Multiplex Section Protection – 1+1 (MSP)with necessary interfaces to meet the voice and data communication requirement among 220kV Sarjapura, 220kV Malur, 220kV Ekarajapura, 220kV Hosakote_New S/s. These directions shall exclude protected (1+1) local patching among equipment (if any). The suitable DC Power Supply and backup to be provided for communication equipment. The 8command Digital Tele Protection Coupler (DTPC) with 220V DC source on E1 for each 220kV lines at both ends to be provided.

III. FOTE/FODP panel shall be installed in the new Bay Kiosk/ Switchyard Panel Room (SPR). The FOTE under present scope shall be integrated by TSP with the existing FOTE at remote end Sub-stations ie., 220kV Sarjapura, 220kV Malur, 220kV Ekarajapura, 220kV Hosakote_New S/s which shall be communicating with respective control center. TSP to provide necessary FODP sub rack / Splice trays/ Patch cords etc. and optical interfaces/equipment in the existing FOTE/FODP panels for integration with the existing FOTE for onwards data transmission.

In case spare optical direction is not available in the existing FOTE the TSP shall coordinate with station owner to reconfigure the directions in existing FOTE at control room. Alternatively, The TSP may integrate the FOTE under the present scope with existing FOTE in the nearby Kiosk connected to the control room FOTE (if available with spare direction). For this purpose, TSP shall provide necessary FODP sub rack / Splice trays/ Patch cords etc. and suitable optical interfaces/ equipment in the existing FOTE/FODP panels in another Kiosk (SPR).

IV. FOTE & FODP can be accommodated in same panel to optimize space.

V. The new communication equipment under the present scope shall be compatible for integration with existing KPTCL NMS of OPGW. The local configuration of the new communication equipment shall be the responsibility of TSP. The configuration work in the existing centralized NMS for integration of new Communication equipment shall be done by

KPTCL Team, however all the necessary support in this regard shall be ensured by TSP.

The maintenance of all the communication equipment and software thereof including FOTE, PMU, FODP, approach cable, DCPS along with Battery Bank shall be the responsibility of TSP.

C.10.0 Specific Requirement for Phasor Measurement Units (PMUs)

TSP shall supply, install & commission required No. of Phasor Measurement Units (PMUs) PMUs at all the locations under the scope of TSP under this RFP as per CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022 (along with all amendments if any), and all the applicable Regulations, Standards, Guidelines issued time to time. The signal list shall be as per the Annexure-I Part-B of CERC Guidelines on “Interface Requirements” 2024. These PMUs shall be provided with GPS clock and LAN switch and shall connect with LAN switch of control room of respective substations/ generating stations with Fibre Optic cable. These PMUs shall be connected with the FOTE at Substation/ generating stations for onwards data transmission to the PDC (Phasor Data Concentrator) located at respective SLDC&RLDC. Configuration work in existing PDC at SLDC/RLDC for new PMU integration shall be done by respective TSP in co-ordination withSLDC/RLDC.The maintenance of all the PMUs and associated equipment shall be the responsibility of TSP.

Note: Existing Station owner/s to provide necessary support to integrate different equipment & applications of new extended bays with the existing substation e.g. Communication (through FOTE), Voice etc. for smooth operation and monitoring of new added grid elements.

Appendix-F.1

Repeater Requirements -VOID

- If the repeater location is finalized in the Control Room of a nearby substation, TSP shall provide 1 No. OPGW (96F/48F)as per OPGW in main line to accommodate all OPGW fibers of main line ,on a single Earthwire peak with OPGW Hardware & mid-way Joint Boxes etc. of the line crossing the main line and 1 no. Approach Cable (96F/48F)as per OPGW laid to accommodate all OPGW fibers of main line ,with all associated hardware fittings, to establish connectivity between crossing point of main transmission line up to the repeater equipment in substation control room.
  TSP shall co-ordinate for Space and DC power supply sharing for repeater equipment.

  TSP shall provide required FODP, FOTE (with STM-16 capacity) with suitable interfaces require for link budget of respective link.

  OR

- If the repeater location is finalized in the nearby substation premises, the TSP shall identify the Space for repeater shelter in consultation with station owner. Further TSP shall provide 1 No. OPGW (96F/48F) as per OPGW in main line to accommodate all OPGW fibers of main line, on a single Earthwire peak with OPGW Hardware & mid-way Joint Boxes etc. of the line crossing the main line and 1 No. Approach Cable (96F/48F)as per OPGW laid to accommodate all OPGW fibers of main line, with all associated hardware fittings, to establish connectivity between crossing point of main transmission line up to the substation where the repeater shelter is to be housed.
  TSP shall provide repeater shelter along with FODP, FOTE (with STM-16 capacity) with suitable interfaces require for link budget of respective link, reliable power supply provisioning for AC and DC supply, battery bank, Air Conditioner and other associated systems.

  OR

- If the repeater location is finalized on land near the transmission tower. TSP shall make the provisions for Land at nearby tower for repeater shelter. Further TSP shall provide required. Approach Cable (96F/48F)as per OPGW laidin main line to accommodate all OPGW fibers of main line,with all associated hardware fittings to establish connectivity up to the location of repeater shelter. TSP shall provide repeater shelter along with FODP, FOTE (with STM-16 capacity) with suitable interfaces require for link budget of respective link,

reliable power supply provisioning for AC and DC supply, battery bank, Air Conditioner and other associated systems

Maintenance of OPGW Cable and **OPGW Hardware**, repeater equipment & items associated with repeater shelter shall be responsibility of TSP.

Annexure-F.1

Next Generation Firewall (NGFW)

TSP shall provide 2 NGFW one in Main & another in Standby mode having electrical ethernet interfaces/ports and placed between FOTE & SAS gateway/s at the substation. All ethernet based applications shall be terminated in the firewall ports directly (e.g. PMU, AMR, VOIP, SAS/SCADA etc.). Each port of firewall shall work as a separate zone. Firewall shall be hardware based with features of Block/Allow/drop and IPSec VPN (network encryption).

The number of ports/interfaces in each firewall (i.e. Main & Standby) shall be minimum 16 nos. TSP shall provide either single firewall or multiple firewalls to meet this interfaces requirement, each for main as well as standby firewall. Minimum throughput of firewall shall be 300 Mbps.

The Firewall shall be managed/ configured as standalone at present and shall also have compatibility to manage/configure through Centralized Management Console (CMC) remotely in future.

Firewall shall be tested and certified for ISO15408 Common Criteria for least EAL4+. Further, the OEM must certify that it conforms to Secure Product Development Life Cycle requirements as per IEC62443-4-1. The firewall shall generate reports for NERC-CIP Compliance.

The specifications for the firewalls are given at **Annexure-F.2** and schematic diagram showing firewall placement given at **Figure F.2**.

Annexure F.2

Specifications of Next Generation Firewall (NGFW)

1. NGFW shall have following features including but not limited to:

   Encryption through IPSec VPN (Virtual Private Network), Deep Packet Inspection (DPI), Denial of service (DoS) and Distributed Denial of Service (DDoS) prevention, Port Block/ Allow, rules/ policies for block/allow, IP (Internet Protocol) & Media Access Control (MAC) spoofing protection, threat detection, Intrusion Prevention System (IPS), Anti-Virus, Anti-Spyware, Man InThe Middle (MITM) attack prevention.
2. The proposed firewall shall be able to handle (alert, block or allow) unknown /unidentified applications e.g. unknown TCP & UDP packets. It shall have the provision to define application control list based on application group and/or list.
3. Firewall shall have feature and also have capability to update the definition/ Signatures of Anti-Virus online as well as offline. Firewall shall also be compatible to update the definitions/signatures through CMC. There shall be a defined process for security patching and firmware up-gradation. There shall be a feature to field validate firmware checksum. The same shall also be validated before using the OEM provided file/binary in the process of firmware up-gradation and security patching
4. Firewall shall have Management Console port to configure remotely.
5. Firewall shall be EMI/EMC compliant in Substation environment as per IEC 61850-3.
6. Firewall shall be rack mounted in existing standard equipment cabinets.
7. Firewall shall have support of SCADA applications (IEC-60870-5-104), ICCP, PMU (IEEE C37.118), Sub-Station Automation System (IEC 61850), Ethernet and other substation environment protocols.
8. Client based Encryption/ VPN must support different Operating System platforms e.g. Windows, Linux & Mac.
9. The solution must have content and comprehensive file detection policies, blocking the files as function of their types, protocols and directions.
10. Firewall shall have logging facility as per standard logs/events format. Firewall shall have features to export the generated/stored logs/events in csv (Comma Separated Value) and also any other standard formats for offline usage, analysis and compliance. Firewall shall have suitable memory architecture and solution to store and be enable to export all logs/events for a period of last 90 days at any given time.

11. Firewall shall have features and be compatible with local as well as central authentication system (RADIUS, LDAP, or TACACS+) for user account and access right management. It shall also have Role Based User management feature.
12. Firewall shall have the capability to configure sufficient number of VLANs.
13. Firewall shall have the capability to support sufficient number of sessions.
14. Firewall shall have provision to configure multiple IP Sec VPNs, at least 100 nos., (one-to-many or many-to-one). Shall support redundant operation with a similar router after creation of all the IP Sec VPN. IPSec VPN shall support encryption protocols as AES128, AES256 and hashing algorithms as MD5 and SHA1. IPSec VPN throughput shall support at least 300 Mbps
15. Firewall shall be capable of SNMP v3 for monitoring from Network Management system. It shall also have SNMPv3 encrypted authentication and access security
16. Firewall shall support in Active/Passive or Active-Active mode with High Availability features like load balancing, failover for firewall and IPsec VPN without losing the session connectivity.
17. Firewall should have integrated traffic shaping (bandwidth, allocation, prioritisation, etc.) functionality
18. Shall support simultaneous operation with both IPv4 and IPv6 traffic
19. Firewall shall be compatible with SNTP/NTP or any other standards for clock synchronization
20. Firewall shall have the features of port as well as MAC based security
21. Firewall shall support exporting of logs to a centralized log management system (e.g. syslog) for security event and information management.
22. Firewall time shall be kept synchronised to official Indian Timekeeping agency, time.nplindia.org.
23. Firewall product shall be provided with all applicable updates at least until 36 months since the applicable date of product shipping to the concerned utility.

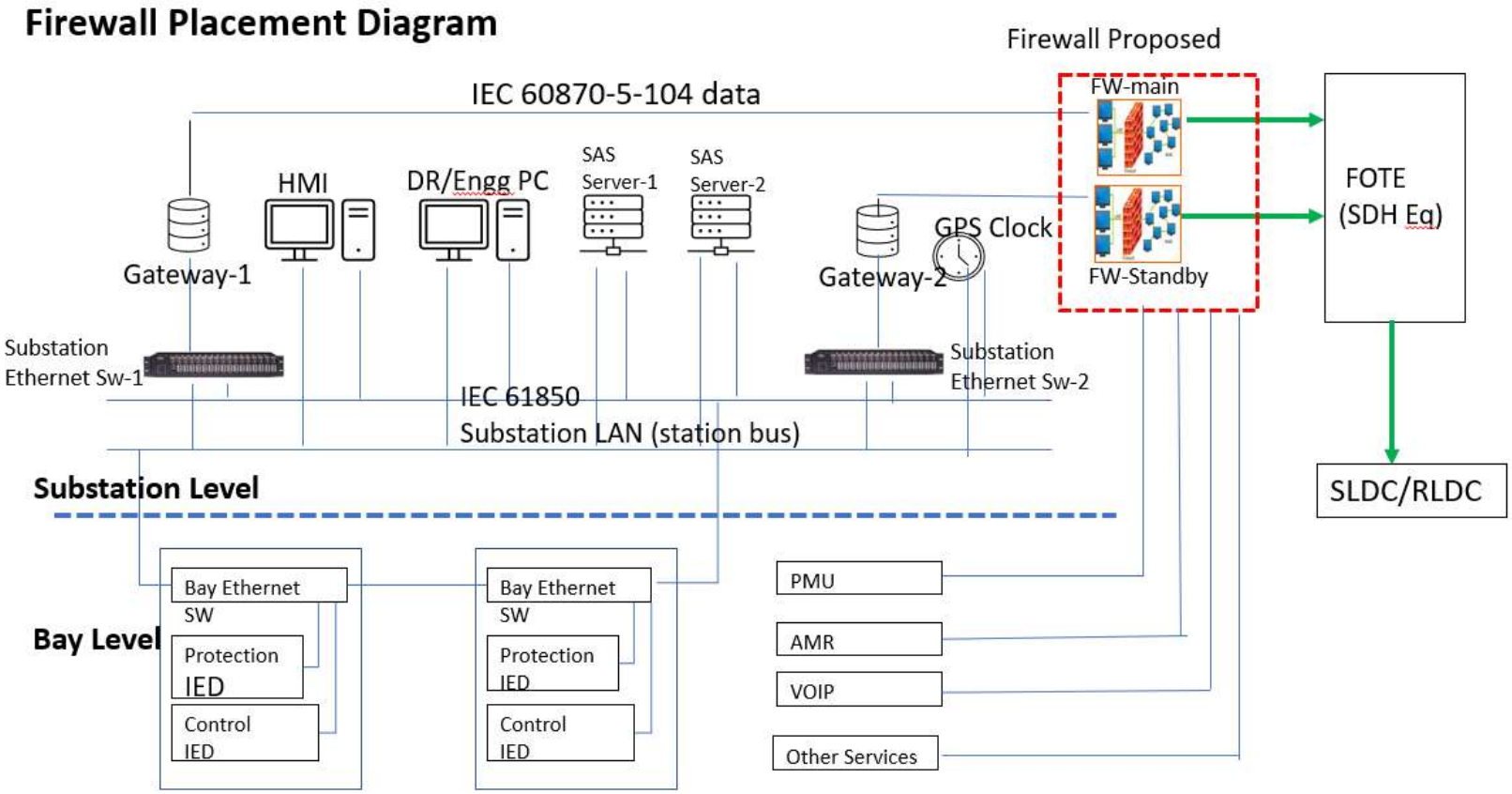
Firewall Placement Diagram
Firewall Proposed
IEC 60870-5-104 data
FW-main
FW-Standby
FOTE
(SDH Eq)
SLDC/RLDC
HMI
DR/Engg PC
SAS
Server-1
SAS
Server-2
GPS Clock
Gateway-1
Gateway-2
Substation
Ethernet Sw-1
Substation
Ethernet Sw-2
IEC 61850
Substation LAN (station bus)
Substation Level
Bay Level
Bay Ethernet
SW
Protection
IED
Control
IED
Bay Ethernet
SW
Protection
IED
Control
IED
PMU
AMR
VOIP
Other Services

Figure F.2

C.11.0 PLCC and PABX:

Power line carrier communication (PLCC) equipment complete for speech, tele-protection commands and data channels shall be provided on each transmission line. The PLCC equipment shall in brief include the following: -

i. Coupling device, Coupling filters line traps, carrier terminals, protection couplers, HF cables, PABX (if applicable) and maintenance and testing instruments.

ii. At new substation, a telephone exchange (PABX) of 24 lines shall be provided at as means of effective communication among various buildings of the substation, remote end substations and with control centres (RLDC/ SLDC) etc.

iii. Coupling devices shall be suitable for 400kV and 220kV voltage class. The pass band of coupling devices shall have sufficient margin for adding communication channel in future if required. Necessary protection devices for safety of personnel and low voltage part against power frequency voltages and transient over voltage shall also be provided.

iv. The line traps shall be broad band tuned suitable for blocking the complete range of carrier frequencies. Line Trap shall have necessary protective devices such as lightning arresters for the protection of tuning device.

v. The carrier terminals shall be of single side-band (SSB) amplitude modulation (AM) type and shall have 4 kHz band width. PLCC Carrier terminals and Protection couplers shall be considered for both ends of the line.

vi. PLCC equipment for all the transmission lines covered under the scheme shall be provided by TSP. PLCC to be provided for following lines are under present scope:

Sl. No	Line name	PLCC configuration
1	400kV Ryapte-Doddataggalli-1	Phase-Phase Coupling
2	400kV Ryapte-Doddataggalli-2	Phase-Phase Coupling
3	400kV Doddataggalli-Kolar-1	Phase-Phase Coupling
4	400kV Doddataggalli-Kolar-2	Phase-Phase Coupling
5	220kV Doddataggalli-Malur-1	Phase-Phase Coupling
6	220kV Doddataggalli-Malur-2	Phase-Phase Coupling

Note: Only DTPC for 220kV Doddataggali-Sarjapura-1&2, Ekarajapura 1&2 and Hoskote_New 1&2 lines as line is combination of Over head and Under Ground cable.

vii. Further, CVT and Wave trap for all 400 kV and 220 kV line bays under present scope shall be provided by TSP.

viii. All other associated equipment like cabling, coupling device and HF cable

shall also be provided by the TSP.

ix. The PLCC Equipment to be provided at both ends of Sub-station for 400kV and 220kV lines.

x. The PLCC Equipment to be provided only at 400kV Ryapte, 400kV Doddatagalli, 220kV Malur.

xi. Two (2) sets of 48 V battery banks for PLCC and communication equipment shall be provided at each new Substation with at least 10-hour battery backup and extended backup, if required.

C.12.0: **Communication through VSAT:**

KPTCL is having captive VSAT communication network for all Sub-stations. The VSAT equipment will be provided by KPTCL and the estimated cost of equipment will be intimated.

In addition, License fee, Annual bandwidth charges, AMC cost and other statutory charges pertaining to VSAT on quarterly basis needs to be paid. The demand note will be issued from KPTCL to pay the charges. An undertaking agreement on a stamp paper towards payment of VSAT charges has to be submitted to KPTCL (as a back-up communication)

SPECIFIC TECHNICAL REQUIREMENTS FOR INTEGRATION OF COMMUNICATION EQUIPMENT WITH STATE LEVEL NMS & REGIONAL UNMS:

The new communication equipment/ system for all the substations under the present scope shall be compatible for integration with existing regional level NMS system/ Centralized Supervision and Monitoring System (CSMS) i.e. Regional UNMS. The local configuration of the new communication equipment at the station end shall be the responsibility of TSP as per **Annexure E.1**. The configuration work in the existing centralized NMS/ CSMS at Control center end, for integration of new Communication equipment/ system shall be done by Regional ULDC Team/ NMT, however all the necessary support in this regard shall be ensured by TSP.

Requirement for integration of Communication Equipment with Regional UNMS:

1. TSP shall ensure that NMS/EMS/NE supplied by them is NBI compliant and all FCAPS functionality is supported in the NBI such as NE Inventory, Hardware Inventory – Shelf/Slot/Card/SFP/Port, Topology, Protections, Alarms, Performance- real time and periodic, Performance KPI parameters (E-1, STM, Ethernet) , Remote Configuration, Cross Connects, Trails and Circuits, Services Provisioning (NE), E-1 , STM, Ethernet , TX and RS Trace, loop back and details are published in the NBI guide for the configuration parameters.

2. TSP shall be obliged to provide/share all necessary documentations such as NBI Guide/MIB/IDL/WSDL/API files/ etc. for onward integration of their NMS/EMS/NE with regional UNMS.

3. The following support shall be provided by TSP for integration of their supplied equipment with regional UNMS:

   - Enabling and activating NBI license in their EMS/NMS and providing NBI login access along with User credentials
   - Assist in verifying NBI Connectivity with UNMS vendor for the successful communication and retrieval of data.
   - Assist in troubleshooting (if required) for NBI connectivity along with UNMS vendor for the communication and retrieval of data.

4. For standalone NE which is not integrated with any EMS/NMS, TSP shall provide modality of complete FCAPS data acquisition as above through industry standard programmatic methods and provide the CLI command manual.

BOQ of PLCC for 400kV lines at 400kV Ryapte Sub-station

400kV lines: 1) DC line from Ryapte to proposed Doddathagalli(135km)

Sl. No	Name of materials (Supply & Erection)	Unit	At 400kV Ryapte	At 400kV Doddathagalli	Total Quantity required
01	Wave Trap 1mH, 3150A, 63kA dual band, 50 to 100kHz and 100 to 500kHz Pedestal Mounting along with mounting structure PI and Hardware (Ph-Ph Coupling)	No	4	4	8
02	(LMU+LMDU) Coupling Device	Set.	2	2	4
03	HF Coaxial Cable 75 Ohms	Km	0.5	0.5	1
04	PLCC Terminal(Carrier Cabinet) Single Channel	No	3	3	6
05	Protection Coupler -4 Command version	No	2	2	4
06	DTPC- 8 command with provision for interface with SDH on E1 on E1 (220kV DC Source)	No	1	1	2
07	48 Volts 400Ah Battery Set	Set	02	-	02
08	48V Battery Charger with 100Amps current rating suitable for 400Ah battery.	No	02	-	02
09	DCDB with independent change over b/w DC Source1 & DC Source 2, with 20 Feeders.	No	01	-	01
10	EPAX 16/8/8	No	01	-	01
11	Telephones	No	10	-	10

The BOQ of FOTE at 400kV Ryapte Sub-station

Sl No	Description	Unit	At 400kv Ryapte
	MAIN EQUIPMENTS		
1	SDH EQUIPMENT (STM-16 MADM UPTO 5MSP PROTECTED DIRECTIONS)-BASE EQUIPMENT (COMMON CARDS, CROSS CONNECT/CONTROL CARDS, OPTICAL BASECARDS, POWER SUPPLY CARDS, POWER CABLING, OTHER HARDWARE ANDACCESSORIES INCLUDING SUB RACKS, PATCH CORD, DDF ETC FULLY EQUIPEDEXCLUDING OPTICAL INTERFACE & TRIBUTARY CARDS	No	1
	Optical Interface		
2	Trans receiver		

A	Optical Line Interface Card (150-175km)		2
	Tributary Interface		
3	E1 Interface card (Min. 16 interfaces per card) - 5MSP	No	2
4	Ethernet interface 10/100 Mbps with Layer-2 switching (Min,2x1Gbps+ 4x100/10 Mbps ports) without SFP - 5MSP.	No	2
5	1x1000 base LX SFP (GIGABIT ETHERNET INTERFACES 10/100 MBPS WITH LAYER-2 SWITCHING)	Set	2
6	Cabinet Equipment to house SDH Equipment + Optical cards + Tributary Cards, Drop/Insert MUX Equipments and DACS Equipment	Set	4
7	220V DC to 48V DC CONVERTER for SDH Equipment	No	1
8	Fail over switch/Router	No	1
9	VOIP Phone	No	2

The BOQ of PLCC for 400kV lines at 400kV Doddataggalli Sub-station

400kV lines: DC line to 400kV Kolar line

Sl. No	**Name of materials (Supply & Erection)**	**Unit**	**At 400kV Doddathagalli**	**At 400kV Kolar**	**Total Quantity required**
01	Wave Trap 1mH, 3150A, 63kA dual band, 50 to 100kHz and 100 to 500kHz Pedestal Mounting along with mounting structure PI and Hardware (Ph-Ph Coupling)	No	4	4	8
02	(LMU+LMDU) Coupling Device	Set.	2	2	4
03	HF Coaxial Cable 75 Ohms	Km	0.5	0.5	1
04	PLCC Terminal(Carrier Cabinet) Single Channel	No	3	3	6
05	Protection Coupler -4 Command version	No	2	2	4
06	DTPC- 8 command with provision for interface with SDH on E1 (220kV DC Source)	No	1	1	2
07	48 Volts 400Ah Battery Set	Set	02	-	02
08	48V Battery Charger with 100Amps current rating suitable for 400Ah battery.	No	02	-	02
09	DCDB with independent change over b/w DC Source1 & DC Source 2, with 20 Feeders.	No	01	-	01
10	EPAX 16/8/8	No	01	-	01

11	Telephones	No	10	-	10

The BOQ of PLCC for 220kV lines at 400kV Doddataggalli Sub-station

220kV lines: 1) DC line to 220kV Malur(12km)

2) DC line to 220kV Ekarajapura(20km) (OH+UG)

3) DC line Hoskote_New(25km) (OH+UG)

4) DC line Sarjapura(40km) (OH+UG)

Sl. No	Name of materials (Supply & Erection)	Unit	At 400kV Doddataggalli	At 220kV Malur	At 220kV Ekarajapura	At 220kV Hoskote_New	At 220kV Sarjapur	Total Quantity
01	Wave Trap 0.5mH, 2000A, 50kA, 50-500kHz Pedestal Mounting along with mounting structure PI and Hardware. Inter-circuit coupling	No.	4	4	-	-	-	8
02	LMU+LMDU (Coupling device)	Set.	2	2	-	-	-	4
03	HF Coaxial Cable 75 Ohms	Km	1	0.5	-	-	-	1.5
04	PLCC Terminal(Carrier Cabinet) Single Channel	No	1	1	-	-	-	2
05	Protection Coupler -4 Command version	No	1	1	-	-	-	2
06	DTPC- 8 command with provision for interface with SDH and Direct fiber-in type (220kV DC Source)	No	4	1	1	1	1	8
	Mandatory Spares for PLCC							
07	Power Supply module	Nos.	01		-	-		01

08	Protection Coupler -4 Command version	Nos.	01		-	-		01

The BOQ of FOTE at 400kV Doddataggalli Sub-station

Sl No	Description	Unit	At 400kv Doddataggalli SS
	MAIN EQUIPMENTS		
1	SDH EQUIPMENT (STM-16 MADM UPTO 5MSP PROTECTED DIRECTIONS)-BASE EQUIPMENT (COMMON CARDS, CROSS CONNECT/CONTROL CARDS, OPTICAL BASECARDS, POWER SUPPLY CARDS, POWER CABLING, OTHER HARDWARE ANDACCESSORIES INCLUDING SUB RACKS, PATCH CORD, DDF ETC FULLY EQUIPEDEXCLUDING OPTICAL INTERFACE & TRIBUTARY CARDS	No	1
	Optical Interface		
2	Trans receiver		
A	S16.1 SFP -(30km)	No	8
B	L16.1 SFP -(30-50 km) -	No	2
	Tributary Interface		
3	E1 Interface card (Min. 16 interfaces per card) - 5MSP	No	2
4	Ethernet interface 10/100 Mbps with Layer-2 switching (Min,2x1Gbps+ 4x100/10 Mbps ports) without SFP - 5MSP.	No	2
5	1x1000 base LX SFP (GIGABIT ETHERNET INTERFACES 10/100 MBPS WITH LAYER-2 SWITCHING)	Set	2
6	Cabinet Equipment to house SDH Equipment + Optical cards + Tributary Cards, Drop/Insert MUX Equipments and DACS Equipment	Set	4
7	220V DC to 48V DC CONVERTER for SDH Equipment	No	1
8	Fail over switch/Router	No	1
9	VOIP Phone	No	2

Note- The Communication requirement for kolar S/s shall be as per PGCIL.

The Optical Trans receiver for Doddataggalli direction should be compatible to existing SDH(STM-16) FOTE system at Kolar-PGCIL Sub-station.

Frequently Asked Queries:

Transmission Line:

1.1 Please clarify that whether shutdowns for crossing of existing transmission lines of POWERGRID/STUs/ Power Evacuation Lines from Generation Plants/ Any other Transmission Licensee will be given to TSP on chargeable basis or free of cost.

Reply: Shutdowns for crossing of existing transmission lines of POWERGRID/ STUs/ Power Evacuation Lines from Generation Plants/ Any other Transmission Licensee will be given to TSP by the concerned owner of the lines as per their own terms and conditions. As far as shutdown of ISTS lines are concerned the same can be availed by approaching respective Regional Power Committee.

1.2 We understand that the suggested swing angle criteria are applicable for Suspension Insulator in Suspension Tower. Further, you are requested to provide similar swing angle and clearance criteria for Pilot Insulator with Jumper and Jumper.

Reply: It is clarified that the swing angle criteria (as mentioned in RFP) for transmission lines is applicable for Suspension Insulator in Suspension Tower. Further, as per Clause 2.2 of Specific Technical Requirements for transmission lines, Transmission service Provider (TSP) shall adopt any additional loading/design criteria for ensuring reliability of the line, if so desired and /or deemed necessary.

1.3 We request you to kindly allow that use of diamond configuration at Power line crossings and the existing owner of the lines may be directed to allow the same for the successful bidders.

Reply: Power line crossing including Diamond configuration is the responsibility of the TSP. TSP shall formally submit the profile of the crossing section to the owner of the existing line suggesting proposed crossing alternatives. The crossing will have to be carried out as per approval of owner of the existing line.

1.4 It is requested you to kindly provide present status of Forest Clearances if any transmission line corridor area falling in wildlife forest / reserve forest/ mangroves.

Reply: Based on the preliminary route survey, the process of initiation of forest clearance for the forest stretches, if any, enroute the proposed line alignment will be initiated by way of writing letters to the concerned authority (ies). However, it may be noted that it will be the responsibility of TSP for obtaining

forest clearance for the forest stretches as provided in the survey report and also for any forest area encountered during detailed survey.

1.5 For transmission line, no special requirement is specified for type of Insulator and creepage in RFP document. Hence it is understood that bidder can decide the type of insulator along with creepage requirement based on general CEA regulations and relevant standards. Kindly confirm.

Reply: The minimum specific creepage distances shall be decided for the pollution condition in the area of installation. It shall be as per CEA regulations and relevant standards.

Substation

2.1 We understand that space for storage of O&M spare shall be provided by the existing owner within the station boundary without any cost. Kindly confirm.

Reply: Space for storage of O&M spares shall be arranged by TSP on its own.

2.2 With reference to subject scheme of existing sub-station, we assumed following scope of work:

(a) We assumed internal road is available and need not to be consider in the present scope of work.

(b) Drainage is available and need not to consider in the present scope of work.

(c) Cable trench extension adjacent to Main cable trench only under present scope of work.

(d) Levelled area being provided by developer for bay extension.

Reply: Regarding requirement of internal road, drainage, cable trench, leveling of the bay extension area, bidder is advised to visit site and acquaint themselves with the provisions/facilities available at substation.

2.3 Kindly provide the soil investigation report of soil parameters of existing substation.

Reply: Bidder is advised to visit the substation site and ascertain the requisite parameters.

2.4 Kindly confirm, energy accounting of aux. power consumption. Whether it will be on chargeable basis or part of transmission loss.

Reply: It will be on a chargeable basis.

2.5 We understand that VMS requirement is for unmanned stations only. For Manned stations VMS is not compulsory.

Reply: VMS shall be provided in line with requirements of RfP document.

2.6 It is understood that Construction water and power shall be provided free of cost to TSP by the respective substation owner for construction of new bays.

Reply: Arrangement of construction power and water is in the scope of TSP.

2.7 It is understood that the existing fire hydrant system shall be extended by the TSP for bay extension.

Reply: Existing fire hydrant system shall be extended from existing system (if required)

2.8 We understood that no any dedicated metering CT and CVT is required for Line/feeders. Further, we understood that requisite Energy meters for various 765 kV, 400 kV and 220 kV Feeders shall be provided and installed by CTU free of cost to TSP.

Reply: Dedicated metering CT and CVT are not required for line/feeders. Metering core of existing CT/CVT can be used provided accuracy class matches with metering requirement. Requisite Special Energy Meters shall be provided and installed by CTU at the cost of TSP in C&P panel subject to space availability, else, in separate metering panel (to be provided by TSP at its cost).

2.9 Please clarify whether the spare 765 kV single phase Reactor unit for Bus reactor shall be provided with 1ph 765 kV CB.

Reply: As per RfP, the spare 1-Ph reactor unit shall be utilized for all the bus and switchable line reactor banks (including for future reactor banks). Hence, 1ph 765 kV CB shall also be provided with spare 1-Ph reactor for utilizing with bus reactor as well as switchable line reactor.

2.10 It is understood that existing busbar protection has provision for future bays and also PUs are available for future bays. BPC to confirm availability of CU and PU for bays under present scope of work at existing substations. BPC may kindly confirm availability of communication ports for integrating new PUs with the existing CUs at existing substations.

Reply: Bus Bar Protection with Central Unit (CU) is required for the new bus section as specified in RfP. Peripheral Units (PUs) shall be provided by the respective bay owner. Further, augmentation/replacement of existing CU, if required, to meet the system requirement shall also be provided for proper functioning of bus bar protection.

2.11 For SCADA, it is understood that necessary process I/O shall be available for future bays and accordingly license for same. BPC to confirm.

Reply: Necessary process I/O along with license shall be in the scope of the successful bidder.

2.12 No separate FF system is envisaged under the present scope of work for existing substation. BPC to confirm.

Reply: Existing fire-fighting systems shall be extended to meet the additional requirements under present scope.

2.13 PLCC for 220 kV Lines are not under the scope of TSP. BPC to Confirm.It is requested to provide Type of Coupling for 220 kV Transmission Lines under present scope.

Reply: PLCC for 220 kV line is in the scope of developer of the line.

Phase to phase coupling for 220 kV D/C and phase to phase coupling for 220 kV S/C shall be applicable for PLCC.

2.14 BPC is requested to confirm the availability of space in the existing control rooms at existing substation for execution of extension work under current project.

Reply: Switchyard Panel Rooms are generally required for AIS type substation and relay room are required for GIS type substation. Further, if needed, the control room shall be augmented as per requirement.

Communication

3.1 What are the usage of OPGW, FOTE, PMU etc. under communication requirement of RFP?

Reply: User shall be responsible for providing compatible equipment along with appropriate interface for uninterrupted communication with the concerned control center and shall be responsible for successful integration with the communication system provided by STU.

Communication systems e.g. OPGW, FOTE etc. and PMU are required for grid operation through RLDC/SLDC, speech communication, tele-protection and tele-metering.

3.2 Is space for installation of communication panels are provided to TSP in existing Substations incase new bays are in the scope of TSP?

Reply: The space related issues are deliberated in the RFP itself. TSP to install FOTE/FODP panels in the new Bay Kiosk (Switchyard Panel Room (SPR)) / Bay Kisok/ Relay Panel Room (in case of GIS S/s). Further, TSP to connect and integrate the proposed FOTE with the existing FOTE in the control room to complete the communication path upto RLDC.

In Case 132 kV Substation TSP shall accommodate the said panels either by extension of existing control room or other arrangements.

3.3 How are PMUs integrated for new bays at existing Substations?

Reply: PMU data of new bays to be provided in the ethernet port of switch at control room and thereafter to be connected with existing FOTE of existing substation to send data to PDC of RLDC by TSP. These PMUs shall be provided with GPS clock and LAN switch and shall connect with LAN switch of control room of respective substations with Fibre Optic cable.

3.4 Is Spare direction available in existing FOTE for integration with new bay kiosk FOTE

Reply: The FOTE under present scope shall be integrated by TSP with the existing FOTE at control room of substation for onwards data transmission.

In case spare optical direction is not available in the existing FOTE at the control room, the TSP shall coordinate with station owner to reconfigure the directions in existing FOTE at control room.

3.5 What is the distance from LILO point to proposed substation for feasibility of repeater station?

Reply: Tentative Location of LILO point shall be as per survey report of BPC however exact location to be ascertained after detailed survey by TSP.

3.6 What is the make and model of existing OPGW in case LILO of main line at new substation?

Reply: All OPGW (alongwith optical fibers) meet Central Electricity Authority (Technical Standards for Communication System in Power System Operations) Regulations, 2020 and bidder shall install OPGW accordingly.

3.7 In case of LILO of existing line at new substation who shall provide PMUs at existing substation bays?

Reply: TSP to provide PMUs for all bays under their scope of RFP.

Schedule: 2

Scheduled COD

[Note: As referred to in the definition of "Element", "Scheduled COD", and in Articles 3.1.3 (c), 4.1 (b) and 4.3 (a) of this Agreement]

Sl. No.	Name of the Transmission Element	Scheduled COD	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
1.	Establishment of 5x500 MVA, 400/220 kV S/s at Ryapte in Tumkur District along with 2x125MVAr 400 kV Bus Reactors 400/220 kV ICTs: 5 Nos. (5x500 MVA) 400 kV ICT Bays: 5 Nos. 400 kV Line bays (along with space provision for switchable line reactors) : 2 Nos. 125 MVAr, 420 kV Bus reactor – 2 Nos. 400 kV Bus reactor bay: 2 Nos 220 kV ICT Bays: 5 Nos 220 KV line Bay - 8 No. 220 kV TBC bay – 2 No. 220 kV BC bay – 2 No 220 kV Sectionalization bay: 1 set 400 kv Bus PT bay- 2 Nos 220 kv Bus PT bay- 4 Nos **Space For Future Provision:** 400/220 KV ICTs - 5 Nos.	24 months from effective date	100%	All elements of scheme are required to be commissioned simultaneously as their utilization is dependent on each other.

Sl. No.	Name of the Transmission Element	Scheduled COD	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
	400 KV ICT bay – 5 Nos. 400 kV Bus Reactor: 3 Nos 400 kV Bus Reactor bays : 3 Nos 220 kV ICT Bays: 5 Nos 220 Kv line bays – 8 Nos 400 kV Line bays (along with space provision for switchable line reactors) : 4 Nos.			
2.	400kV DC line (Quad moose conductor) from Prop. 400/220 kV Ryapte Sub-station to Prop. 400/220 kV Doddathaggalli S/s.			
3.	Establishing 3X500 MVA, 400/220kV GIS sub-station at Doddathaggalli (Near Hosakote) along with 2x125 MVAr, 400 kV Bus Reactors. 400/220 kV ICTs: 3 no. 400 kV ICT Bays: 3 Nos 400 kV Line bays : 4 Nos 125 MVAr, 420 kV Bus reactor – 2 No 400 kV Bus reactor bay: 2 Nos 220 kV ICT Bays: 3 Nos 220 kV Line bays: 8 Nos. 220 kV BC bay – 1 No 400 kv Bus PT bay- 2 Nos 220 kv Bus PT bay- 2 Nos			

Sl. No.	Name of the Transmission Element	Scheduled COD	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
	Future Provision: 400 kV line bays – 4 Nos. 400/220 kV ICTs - 2 Nos. 400 kV ICT bays - 2 Nos 400 kV Bus Reactor: 2 Nos. 400 kV Bus Reactor bays: 2 Nos. 220 kV ICT Bays: 2 Nos 220 kV Line bays: 4 Nos			
4.	400kV DC line (Quad moose conductor) from Kolar S/s to Prop. 400/220 kV Doddathaggalli Sub-station with 2 no. of TB at Ex. Kolar S/s of PGCIL by extending existing AIS bus bar along with AIS isolator			
5.	220 kV DC line with Twin Zebra conductor from proposed 400/220 kV Doddathagalli sub-station to existing 220/66kV Malur sub-station with 2 No.s of TB at Malur S/s.			
6.	220kV DC line with Twin Zebra conductor/UG cable (2000/2500 sqmm) from proposed 400/220 kV Doddathagalli sub-station to 220kV Ekarajapura sub-station with 2 No.s of outdoor GIS TB at Ekarajapura S/s by extending existing AIS bus bar along with AIS isolator.			

Sl. No.	Name of the Transmission Element	Scheduled COD	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
7.	220kV DC line with Twin Zebra conductor/UG cable (2000/2500 sqmm) from proposed 400/220 kV Doddathagalli sub-station to proposed 220kV Hosakote New sub-station.			
8.	220kV DC line with Twin Zebra conductor/ UG Cable (2000/2500 sqmm) from proposed 400/220kV Doddathagalli to Sarjapura AIS S/s ' with 2 No.s of outdoor GIS TB at Sarjapura S/s by extending existing AIS bus bar along with AIS isolator.			

The payment of Transmission Charges for any Element, irrespective of its successful commissioning on or before its Scheduled COD, shall only be considered after successful commissioning of the Element(s), which are pre-required for declaring the commercial operation of such Element as mentioned in the above table.

Scheduled COD for the Project is: 24 months from effective date

Schedule: 3

Safety Rules and Procedures

[Note: As referred to in Articles 5.6 of this Agreement]

1: **Site Regulations and Safety:**

The TSP shall establish Site regulations within sixty (60) days from fulfilment of conditions subsequent, as per Prudent Utility Practices setting out the rules to be observed till expiry of the Agreement at the Site and shall comply therewith.

Such Site regulations shall include, but shall not be limited to, rules in respect of security, safety of the Project, gate control, sanitation, medical care, and fire prevention, public health, environment protection, security of public life, etc.

Copies of such Site regulations shall be provided to the Nodal Agency and the STU for the purpose of monitoring of the Project.

2: **Emergency Work:**

In cases of any emergency, the TSP shall carry out all necessary remedial work as may be necessary.

If the work done or caused to be done by any entity, other than the TSP, the TSP shall, reimburse the actual costs incurred, to the other Party carrying out such remedial works.

3: **Site Clearance:**

In the course of execution of the Agreement, the TSP shall keep the Site reasonably free from all unnecessary obstruction, storage, remove any surplus materials, clear away any wreckage, rubbish and temporary works from the Site, and remove any equipment no longer required for execution of the Agreement. After completion of all Elements of the Project, the TSP shall clear away and remove all wreckage, rubbish and debris of any kind from the Site, and shall leave the Site clean and safe.

4: **Watching and Lighting:**

The TSP shall provide and maintain at its own expense all lighting, fencing, and watching when and where necessary for the proper construction, operation, maintenance / repair of any of the Elements of the Project, or for the safety of the owners and occupiers of adjacent property and for the safety of the public, during such maintenance / repair.

Schedule: 4

Computation of Transmission Charges

1.1 General

The Monthly Transmission Charges to be paid to the TSP for providing Transmission Service for any Contract Year during the term of the Agreement shall be computed in accordance with this Schedule and paid as per provision of this agreement.

Illustration regarding payment of Transmission Charges under various scenarios (considering definitions of Contract Year, Expiry Date & Monthly Transmission Charges above) is as below: -

Illustration-1: In case the Project Elements achieve COD as per Schedule

Quoted Transmission Charges: **Rs. 140 Million**

Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	28	1-Feb-2018	1-Feb-2018	25%
Element 2	38	1-Dec-2018	1-Dec-2018	75%

Tariff Payable as follows:

Transmission Charges for Element 1			**Transmission Charges for Element 2**		
1-Feb-18 to 31-Mar-18	140 X 25% X ((28+31)/365)	5.65		--	0.00
1-Apr-18 to 30-Nov-18	140 X 25% X (244/365)	23.39		--	0.00
1-Dec-18 to 31-Mar-19	140 X 100% X (121/365)				46.41
2	140 X 100% X 1				140
3	140 X 100% X 1				140
4	140 X 100% X 1				140
5	140 X 100% X 1				140
…….					
……..					
36 (1-Apr to 30-Nov)	140 X 100% X (244/365)				93.59

Illustration-2: In case of extension of Scheduled COD as per Article 4.4.1 & 4.4.2 of this Agreement

Quoted Transmission Charges: **Rs. 140 Million**

Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	20	1-Feb-2018	1-Jul-2018	25%
Element 2	28	1-Oct-2018	1-Dec-2018	75%

Tariff Payable as follows:

Transmission Charges for Element 1			**Transmission Charges for Element 2**		
1-Feb-18 to 31-Mar-18	--	0.00		--	0.00
1-Apr-18 to 30-Jun-18	--	0.00		--	0.00
1-Jul-18 to 30-Nov-18	140 X 25% X (153/365)	14.67		--	0.00
1-Dec-18 to 31-Mar-19	140 X 100% X (121/365)				46.41
2	140 X 100% X 1				140
3	140 X 100% X 1				140
4	140 X 100% X 1				140
5	140 X 100% X 1				140
……					
……..					
36 (1-Apr to 30-Nov)	140 X 100% X (244/365)				93.59

Illustration-3: In case of delay in achieving COD of Project & all individual Elements (COD of the Project achieved in Contract Year 1)

Quoted Transmission Charges: **Rs. 140 Million**

Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	20	1-Feb-2018	1-Dec-2018	25%
Element 2	28	1-Oct-2018	1-Dec-2018	75%

Tariff Payable as follows:

Transmission Charges for Element 1			**Transmission Charges for Element 2**		
1-Feb-18 to 31-Mar-18	--	0.00		--	0.00
1-Apr-18 to 30-Sept-18	--	0.00		--	0.00
1-Oct-18 to 30-Nov-18	--	0.00	1-Oct-18 to 30-Nov-18	--	0.00
1-Dec-18 to 31-Mar-19	140 X 100% X (121/365)				46.41
2	140 X 100% X 1				140
3	140 X 100% X 1				140
4	140 X 100% X 1				140
5	140 X 100% X 1				140
…….					
……..					
36 (1-Apr to 30-Nov)	140 X 100% X (244/365)				93.59

Illustration-4: In case of delay in achieving COD of Project & all individual Elements (COD of the Project achieved in Contract Year other than Contact Year 1)

Quoted Transmission Charges: **Rs. 140 Million**

Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	38	1-Oct-2019	1-May-2020	25%
Element 2	38	1-Oct-2019	1-May-2020	75%

Tariff Payment to be paid as:

Transmission Charges for Element 1			**Transmission Charges for Element 2**		
1-Oct-19 to 31-Mar-20	--	0.00	1-Oct-19 to 31-Mar-20	--	0.00
1-Apr-20 to 30-Apr-20	-	0.00	1-Apr-20 to 30-Apr-20	-	0.00
1-May-20 to 31-Mar-21	140 X 100% X (335/365)				128.49
2	140 X 100% X 1				140
3	140 X 100% X 1				140
4	140 X 100% X 1				140
5	140 X 100% X 1				140
…….					
……..					
36 (1-Apr to 30-Apr)	140 X 100% X (30/ 365)				11.51

Illustration5: In case of delay in achieving COD of Element but Project COD achieved on time

Quoted Transmission Charges: **Rs. 140 Million**

Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	20	1-Feb-2018	1-Jul-2018	25%
Element 2	30	1-Dec-2018	1-Dec-2018	75%

Tariff Payable as follows:

Transmission Charges for Element 1			Transmission Charges for Element 2		
1-Feb-18 to 31-Mar-18	--	0.00		--	0.00
1-Apr-18 to 30-Jun-18	--	0.00		--	0.00
1-Jul-18 to 30-Nov-18	140 X 25% X (153/365)	14.67		--	0.00
1-Dec-18 to 31-Mar-19	140 X 100% X (121/365)				46.41
2	140 X 100% X 1				140
3	140 X 100% X 1				140
4	140 X 100% X 1				140
5	140 X 100% X 1				140
……					
……..					
36 (1-Apr to 30-Nov)	140 X 100% X (244/365)				93.59

Illustration-6: In case of early commissioning of Project

Quoted Transmission Charges: **Rs. 140 Million**

Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	38	1-Oct-2019	1-Jul-2019	25%
Element 2	38	1-Oct-2019	1-Jul-2019	75%

Tariff Payment to be paid as:

Transmission Charges for Element 1	**Transmission Charges for Element 2**	
1-July-19 to 31-Mar-20	140 X 100% X (274/365)	105.09
2	140 X 100% X 1	140
3	140 X 100% X 1	140
4	140 X 100% X 1	140
5	140 X 100% X 1	140
……		
……..		
36 (1-Apr to 30-Jun)	140 X 100% X (91/365)	34.91

Illustration-7: In case of early commissioning of an element

Quoted Transmission Charges: **Rs. 140 Million**
Completion Schedule:

Element No.	Completion Schedule in Months	Scheduled CoD of the Element	Actual CoD of the Element	% Charges recoverable on Scheduled CoD of the Element
Element 1	38	1-Oct-2019	1-Apr-2019	25%
Element 2	38	1-Jul-2019	1-Jul-2019	75%

Tariff Payment to be paid as:

Transmission Charges for Element 1			**Transmission Charges for Element 2**		
1-Apr-2019 to 30-Jun-19	140 X 25% X (91/365)	8.72	1-Apr-2019 to 30-Jun-19	--	0.00
1-July-19 to 31-Mar-20	140 X 100% X (274/ 365)				105.09
2	140 X 100% X 1				140
3	140 X 100% X 1				140
4	140 X 100% X 1				140
5	140 X 100% X 1				140
……					
……..					
36 (1-Apr-30-Jun)	140 X 100% X (91/365)				34.91

The Transmission Charges shall be payable on monthly basis as computed above.

1.2 Computation of Monthly Transmission Charges

The Monthly Transmission Charges for any month m in a Contract Year n shall be calculated as below:

For AC System:

a. If Actual Transmission System Availability for the month m of contract year n is greater than or equal to 98% and less than or equal to 98.5%;

   Monthly Transmission Charges MTC(m) = Tmn *1

b. If Actual Transmission System Availability for the month m of contract year n exceeds 98.5% and less than or equal to 99.75%;

   Monthly Transmission Charges MTC(m) = Tmn * (AA/ 98.5%)

c. If Actual Transmission System Availability for the month m of contract year n is greater than 99.75%;

Monthly Transmission Charges MTC(m) = Tmn * (99.75% / 98.5%)

d. If Actual Transmission System Availability for the month m of contract year n is less than 98.5%and greater than or equal to 95.00%;

Monthly Transmission Charges MTC(m) = Tmn * (AA/ 98.5%)

e. If Actual Transmission System Availability for the month m of contract year falls below 95%;

Monthly Transmission Charges MTC(m) = Tmn * (AA/ 98%) - 0.02 * (Tmn * (AA/ 95%)

For DC System:

a. If Actual Transmission System Availability for the month m of contract year n is greater than or equal to 95% and less than or equal to 96%;

Monthly Transmission Charges MTC(m) = Tmn *1

a. If Actual Transmission System Availability for the month m of contract year n exceeds 96% and less than or equal to 99.75%;

Monthly Transmission Charges MTC(m) = Tmn * (AA/ 96%)

c. If Actual Transmission System Availability for the month m of contract year n is greater than 99.75%;

Monthly Transmission Charges MTC(m) = Tmn * (99.75% / 96%)

d. If Actual Transmission System Availability for the month m of contract year n is less than 95% and greater than or equal to 92.00%;

Monthly Transmission Charges MTC(m) = Tmn * (AA/ 95%)

e. If Actual Transmission System Availability for the month m of contract year falls below 92%;

Monthly Transmission Charges MTC(m) = Tmn * (AA/ 95%) - 0.02 * (Tmn * (AA/ 92%)

where:

- AA is the actual Availability, as certified by RPC, as per procedure provided in Schedule 6.
- m is the month in Contract Year ‘n’
- Tmn= Transmission Charges for the month ‘m’ in Contract Year ‘n’ = (=Transmission Charge/ no. of days in the Year n)* no. of days in month m

Provided, no Transmission Charges shall be paid during the period for which the RLDC / SLDC has not allowed the operation of the Element/Project due to the failure of the TSP to operate it as per the provisions of the Grid Code.

1.3 RLDC/SLDC Fee & Charges

The payment of RLDC / SLDC fee & charges, in accordance with relevant regulations of Central Commission / State Commission, shall be the responsibility of the TSP.

Schedule: 5

Quoted Transmission Charges

[Quoted Transmission Charges from Annexure - 21 of the RFP of the Selected Bidder to be inserted here]

[To be incorporated from the Bid of the Selected Bidder submitted during the e-reverse auction after its selection]

Quoted Transmission Charges: Rs. …… Million

Proportionate Transmission Charges payable for each Element of the Project:

Sl. No.	Name of the Transmission Element	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
1.	Establishment of 5x500 MVA, 400/220 kV S/s at Ryapte in Tumkur District along with 2x125MVAr 400 kV Bus Reactors • 400/220 kV ICTs: 5 Nos. (5x500 MVA) • 400 kV ICT Bays: 5 Nos. • 400 kV Line bays (along with space provision for switchable line reactors) : 2 Nos. • 125 MVAr, 420 kV Bus reactor – 2 Nos. • 400 kV Bus reactor bay: 2 Nos • 220 kV ICT Bays: 5 Nos • 220 KV line Bay - 8 No. • 220 kV TBC bay – 2 No. • 220 kV BC bay – 2 No • 220 kV Sectionalization bay: 1 set • 400 kv Bus PT bay- 2 Nos • 220 kv Bus PT bay- 4 Nos	100%	All elements of scheme are required to be commissioned simultaneously as their utilization is dependent on each other.

Sl. No.	Name of the Transmission Element	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
	Space For Future Provision: • 400/220 KV ICTs - 5 Nos. • 400 KV ICT bay – 5 Nos. • 400 kV Bus Reactor: 3 Nos • 400 kV Bus Reactor bays : 3 Nos • 220 kV ICT Bays: 5 Nos • 220 Kv line bays – 8 Nos • 400 kV Line bays (along with space provision for switchable line reactors) : 4 Nos.		
2.	400kV DC line (Quad moose conductor) from Prop. 400/220 kV Ryapte Sub-station to Prop. 400/220 kV Doddathaggalli S/s.		
3.	Establishing 3X500 MVA, 400/220kV GIS sub-station at Doddathaggalli (Near Hosakote) along with 2x125 MVAr, 400 kV Bus Reactors. • 400/220 kV ICTs: 3 no. • 400 kV ICT Bays: 3 Nos • 400 kV Line bays : 4 Nos • 125 MVAr, 420 kV Bus reactor – 2 No • 400 kV Bus reactor bay: 2 Nos • 220 kV ICT Bays: 3 Nos • 220 kV Line bays: 8 Nos. • 220 kV BC bay – 1 No • 400 kv Bus PT bay- 2 Nos • 220 kv Bus PT bay- 2 Nos Future Provision: • 400 kV line bays – 4 Nos.		

Sl. No.	Name of the Transmission Element	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
	• 400/220 kV ICTs - 2 Nos. • 400 kV ICT bays - 2 Nos • 400 kV Bus Reactor: 2 Nos. • 400 kV Bus Reactor bays: 2 Nos. • 220 kV ICT Bays: 2 Nos • 220 kV Line bays: 4 Nos		
4.	400kV DC line (Quad moose conductor) from Kolar S/s to Prop. 400/220 kV Doddathaggalli Sub-station with 2 no. of TB at Ex. Kolar S/s of PGCIL by extending existing AIS bus bar along with AIS isolator.		
5.	220 kV DC line with Twin Zebra conductor from proposed 400/220 kV Doddathagalli sub-station to existing 220/66kV Malur sub-station with 2 No.s of TB at Malur S/s.		
6.	220kV DC line with Twin Zebra conductor/UG cable (2000/2500 sqmm) from proposed 400/220 kV Doddathagalli sub-station to 220kV Ekarajapura sub-station with 2 No.s of outdoor GIS TB at Ekarajapura S/s by extending existing AIS bus bar along with AIS isolator.		
7.	220kV DC line with Twin Zebra conductor/UG cable (2000/2500 sqmm) from proposed 400/220 kV Doddathagalli sub-station to proposed 220kV Hosakote New sub-station.		
8.	220kV DC line with Twin Zebra conductor/ UG Cable (2000/2500 sqmm) from proposed 400/220kV Doddathagalli to Sarjapura AIS S/s ‘		

Sl. No.	Name of the Transmission Element	Percentage of Quoted Transmission Charges recoverable on Scheduled COD of the Element of the Project	Element(s) which are pre-required for declaring the commercial operation (COD) of the respective Element
	with 2 No.s of outdoor GIS TB at Sarjapura S/s by extending existing AIS bus bar along with AIS isolator.		

Schedule: 6

ANNEXURE-V

Procedure for calculation of Transmission System Availability

i) Availability shall be calculated and declared separately for each voltage level.

The transmission system availability shall be declared as per the formula mentioned below. The transmission elements shall be grouped into following categories for the purpose of calculation of availability of transmission systems:

(a) AC transmission lines: Each circuit of AC transmission line shall be considered as one element.

(b) Inter-Connecting Transformers (ICTs): Each ICT bank (three single phase transformer together) shall form one element.

(c) Static VAR Compensator (SVC): SVC along with SVC transformer shall form one element. However, 50% credit to inductive and 50% to capacitive rating shall be given.

(d) Switched Bus Reactor: Each switched Bus Reactor shall be considered as one element.

ii) The Availability of Transmission system shall be calculated as under:

% System Availability for the system

$$= \frac{o \times AVo + p \times AVp + q \times AVq + r \times AVr}{o + p + q + r} \times 100$$

Where

o is Total number of AC lines.

AVo is Availability of o number of AC lines.

p is Total number of switched bus reactors.

AVp is Availability of p number of switched bus reactors.

q is Total number of ICTs.

AVq is Availability of q number of ICTs.

r is Total number of SVCs.

AVr is Availability of r number of SVCs.

iii) The weightage factor for each category of transmission elements shall be as under:

(a) For each circuit of AC line – Surge Impedance Loading for Uncompensated line (SIL) multiplied by Circuit Km. (SIL rating for various voltage level and conductor configuration shall be as per the procedure adopted for power system analysis)

(b) For each ICT bank – The rated MVA capacity.

(c) For SVC – The rated MVAR capacity (inductive & capacitive).

(d) For switched Bus reactor – The rated MVAR capacity.

iv) The availability for each category of transmission elements shall be calculated based on the weightage factor, total hours under consideration and non-available hours for each element of that category. The formulae for calculation of Availability of each category of the Transmission elements are as per Enclosure-**I**.

v) The transmission elements under outage due to following reasons not attributable to the Transmission Licensee shall be deemed to be available:

(a) Shut down to transmission elements availed by other agency/agencies for maintenance or construction of their transmission system.

(b) Manual tripping of line due to over voltage and manual tripping of switched bus reactor as per the directions of RLDC / SLDC.

vi) Outage time of transmission elements for the following contingencies shall be excluded from the total time of the element under period of consideration.

(a) Outage of elements due to acts of God and force majeure events beyond the control of the Transmission Licensee.

Schedule: 7

Entire Bid (both financial bid and technical bid) of the Selected Bidder to be attached here

Schedule: 8

Contract Performance Guarantee

(To be on non-judicial stamp paper of appropriate value as per Stamp Act relevant to place of execution. Foreign entities submitting Bids are required to follow the applicable law in their country.)

In consideration of the ……..[Insert name of the SPV] or Selected Bidder on behalf of the TSP, or Lead Member in case of the Consortium, with address] agreeing to undertake the obligations under the Transmission Service Agreement dated …….and the other RFP Project Documents and the Nodal Agency and the ……..[Insert the name of the BPC], agreeing to execute the *RFP Project Documents* with the Selected Bidder, regarding setting up the Project, the ……. [Insert name and address of the bank issuing the guarantee and address of the head office] (hereinafter referred to as "Guarantor Bank") hereby agrees unequivocally, irrevocably and unconditionally to pay to …… (being the Nodal Agency) at ……[Insert the Place from the address of the Nodal Agency indicated in the TSA] forthwith on demand in writing from the Nodal Agency or any Officer authorized by it in this behalf, any amount up to and not exceeding Rupees …….. Crores (Rs. …….) only [Insert the amount of the bank guarantee] on behalf of M/s. ……. [Insert name of the Selected Bidder or SPV].

This guarantee shall be valid and binding on the Guarantor Bank up to and including …….and shall not be terminable by notice or any change in the constitution of the Bank or the term of the Transmission Service Agreement or by any other reasons whatsoever and our liability hereunder shall not be impaired or discharged by any extension of time or variations or alternations made, given, or agreed with or without our knowledge or consent, by or between parties to the respective agreement.

Our liability under this Guarantee is restricted to Rs. …….. Crores (Rs. ……..) only. Our Guarantee shall remain in force until …….. [Insert the date of validity of the Guarantee as per Article 3.1.2 of this Agreement]. The Nodal Agency, shall be entitled to invoke this Guarantee up to three hundred sixty five (365) days of the last date of the validity of this Guarantee.

The Guarantor Bank hereby expressly agrees that it shall not require any proof in addition to the written demand from …… (in its roles as the Nodal Agency), made in any format, raised at the above mentioned address of the Guarantor Bank, in order to make the said payment to Nodal Agency.

The Guarantor Bank shall make payment hereunder on first demand without restriction or conditions and notwithstanding any objection by ..... [Insert name of the Selected Bidder], …….. [Insert name of the TSP] and / or any other person. The Guarantor Bank shall not require Nodal Agency to justify the invocation of this BANK GUARANTEE, nor shall the Guarantor Bank have any recourse against Nodal Agency in respect of any payment made hereunder.

THIS BANK GUARANTEE shall be interpreted in accordance with the laws of India.

The Guarantor Bank represents that this BANK GUARANTEE has been established in such form and with such content that it is fully enforceable in accordance with its terms as against the Guarantor Bank in the manner provided herein.

THIS BANK GUARANTEE shall not be affected in any manner by reason of merger, amalgamation, restructuring, liquidation, winding up, dissolution or any other change in the constitution of the Guarantor Bank.

THIS BANK GUARANTEE shall be a primary obligation of the Guarantor Bank and accordingly Nodal Agency shall not be obliged before enforcing this BANK GUARANTEE to take any action in any court or arbitral proceedings against …… [Insert name of the SPV] or the Selected Bidder, as the case may be, to make any claim against or any demand on …… [Insert name of the SPV] or the Selected Bidder, as the case may be, or to give any notice to …… [Insert name of the SPV] or the Selected Bidder, as the case may be, or to enforce any security held by the Nodal Agency or to exercise, levy or enforce any distress, diligence or other process against …… [Insert name of the SPV] or the Selected Bidder, as the case may be.

The Guarantor Bank acknowledges that this BANK GUARANTEE is not personal to Nodal Agency and may be assigned, in whole or in part, (whether absolutely or by way of security) by Nodal Agency to any entity to whom the Nodal Agency is entitled to assign its rights and obligations under the Transmission Service Agreement.

The Guarantor Bank hereby agrees and acknowledges that Nodal Agency shall have a right to invoke this Bank Guarantee either in part or in full, as it may deem fit.

Notwithstanding anything contained hereinabove, our liability under this Guarantee is restricted to Rs. …….. Crores (Rs. ……..) only and it shall remain in force until ……[Date to be inserted on the basis of Article 3.1.2 of the Transmission Service Agreement], with an additional claim period of three hundred sixty five (365) days thereafter. This BANK GUARANTEE shall be extended from time to time for such period, as may be desired by …….. [Insert name of the Selected Bidder or Lead Member in case of the Consortium or SPV]. We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only if Nodal Agency serves upon us a written claim or demand.

In witness where of:

Signature .....

Name: .....

Power of attorney No.: ……

For:

…….. [Insert Name of the Bank]

Banker's Seal and Full Address, including mailing address of the Head Office

SCHEDULE: 8A

FORMAT FOR SURETY INSURANCE CONTRACT

(To be on non-judicial stamp paper of appropriate value as per Stamp Act relevant to place of execution.

Foreign entities submitting Bids are required to follow the applicable law of India)

In consideration of the ..... [Insert name of the SPV or Selected Bidder on behalf of SPV or Lead Member in case of the Consortium, with address] (hereinafter referred to as the **'Principal Debtor'** for the purposes of this Surety Insurance Contract as provided in Section 126 of the Indian Contract Act, 1872) having been selected to undertake the Transmission Project on the terms and conditions contained in the Transmission Service Agreement dated ...../ to be executed as per the Model Transmission Service Agreement provided along with the Request for Proposal (**'RFP'**) and other RFP Project Documents, subject to the condition of providing a Performance Bank Guarantee or a Surety Insurance Contract guaranteeing/insuring the due performance of the obligations under the Transmission Service Agreement, to the Central Transmission Utility of India Limited (**'CTUIL'**) [herein after referred to as the Nodal Agency], the [Insert name and address of the Insurance Company issuing the Surety Insurance Contract and address of the head office] (hereinafter referred to as **"Surety"**) hereby agrees unequivocally, irrevocably, absolutely and unconditionally, without demur, to pay to the Nodal Agency at _____ [Insert Place and Address of the Nodal Agency indicated in Transmission Service Agreement, or to the designated Bank Account of the Nodal Agency, namely.....] forthwith on demand in writing from the Nodal Agency, or any Officer authorized by it in this behalf, intimated to the Surety at the address mentioned above, any amount as may be decided by the Nodal Agency not exceeding Rupees .....Crores (Rs.....) only [Insert the amount of the Surety Insurance Contract]

The Surety hereby acknowledges, accepts and confirms that the Surety has received from the Principal Debtor, by way of premium the entire consideration for the Surety to execute, in favour of the Nodal Agency, this Surety Insurance Contract, as extended by the Surety from time to time and assuming the obligation to pay to the Nodal Agency the amount in terms hereof, without any requirement for payment of any other consideration to the Surety by the Principal Debtor, or otherwise.

This Surety Insurance Contract shall be valid and binding on the Surety, as the principal obligation of the Surety to pay on demand by the Nodal Agency, and shall not be terminable by notice or any change in the constitution of the Surety or the term of the Transmission Service Agreement or by any other reasons whatsoever and the liability hereunder of the Surety shall not be impaired or discharged by any extension of time or variations or alternations made, given, or agreed (with or without the knowledge or consent of the Surety) by or between the Principal Debtor and the Nodal Agency.

The liability of the Surety under this Surety Insurance Contract is restricted to Rupees ..... Crores (Rs) only. The Surety Insurance Contract shall remain in force until [Insert the date of validity of the Surety Insurance Contract]. The Nodal Agency shall be entitled to

invoke this Surety Insurance Contract up to three hundred sixty five (365) days after the last date of the validity of this Surety Insurance Contract.

The Surety hereby expressly agrees that it shall not require any proof except for the written demand from the Nodal Agency, containing the statement that the contractor has failed to meet its contractual obligations raised at the above mentioned address of the Surety (address of Surety office should be a place in NCR only) and the Surety shall pay the amount without reference to the Principal Debtor.

Any such demand made by the Nodal Agency on the Surety shall be conclusive and binding not withstanding any difference between the Nodal Agency and the Principal Debtor or any dispute pending before any Court, Tribunal, Arbitrator or any other authority. The Surety undertakes not to revoke this guarantee during its currency without previous consent of the Nodal Agency and further agrees that the Surety Insurance Contract herein contained shall continue to be enforceable till the Nodal Agency discharges this contract or till the expiry of tenor (including Claim period) whichever is earlier.

The Surety shall make payment hereunder within two (02) working days on first demand without restriction or conditions and notwithstanding any objection by the Principal Debtor, namely, ... [Insert name of SPV], or [Insert
name of the Selected Bidder], or ..... [Insert name of the TSP] and/or any other person. The Surety shall not require the Nodal Agency to justify the invocation of this Surety Insurance Contract, nor shall the Surety have any recourse against the Nodal Agency in respect of any payment made hereunder.

This SURETY INSURANCE CONTRACT shall be interpreted in accordance with the laws of India.

This SURETY INSURANCE CONTRACT is being executed by the Surety in terms of the IRDAI (Surety Insurance Contract) Guidelines, 2022 and the Surety hereby acknowledges, accepts and confirms that this Surety Insurance Contract shall be a Contract of Guarantee as provided under Section 126 of the Indian Contract Act, 1872 and further shall be covered by Section 14(3)(b) of the Insolvency and Bankruptcy Code, 2016 (as amended) shall be enforceable as such.

The Surety represents that this Surety Insurance Contract has been established in such form and with such content that it is fully enforceable in accordance with its terms as against the Surety in the manner provided herein.

This SURETY INSURANCE CONTRACT shall not be affected in any manner by reason of merger, amalgamation, restructuring, liquidation, winding up, dissolution or any other change in the constitution of the Surety.
In order to give effect to this surety Bond, the Nodal Agency shall be entitled to act as if the surety insurer were the principal debtor and any change in the constitution of the contractor and/or the surety insurer, whether by their absorption with any other body or corporation or otherwise, shall not in any way or manner affect the liability or obligation of the surety insurer under this surety Bond.

This SURETY INSURANCE CONTRACT shall be a primary obligation of the Surety as a Principal to pay on demand by the Nodal Agency and the Nodal Agency shall not be obliged before enforcing this Surety Insurance Contract to take any action in any court or arbitral

proceedings against the Principal Debtor, namely, ... [Insert name of SPV], or ...[Insert name of the Selected Bidder], or ..[Insert name of the TSP] and/or any other person, as the case may be, to make any claim against or any demand on the Principal Debtor, namely, [Insert name of SPV], or ..... [Insert name of the Selected Bidder], or [Insert name of the TSP] and/or any other person, as the case may be, or to give any notice to Principal Debtor, namely..... [Insert name of SPV], or ..... [Insert name of the Selected Bidder], or [Insert name of the TSP] and/or any other person, as the case may be, or to enforce any security held by the Nodal Agency or to exercise, levy or enforce any distress, diligence or other process against the Principal Debtor, namely, ... [Insert name of SPV], or ..... [Insert name of the Selected Bidder], or ..... [Insert name of the TSP] and/or any other person, as the case may be.

The Surety acknowledges that this Surety Insurance Contract is not personal to the Nodal Agency and may be assigned, in whole or in part, (whether absolutely or by way of security) by Nodal Agency to any entity to whom the Nodal Agency is entitled to assign its rights and obligations under the Transmission Service Agreement Provided that any such assignment shall be in compliance with the relevant provisions of the Insurance Act 1938

The Surety hereby agrees and acknowledges that the Nodal Agency shall have a right to invoke this Surety Insurance Contract either in part or in full, as it may deem fit. In case of invocation of this Surety Insurance Contract in part, besides making payment for the part of Surety Insurance Contract invoked, surety at the request of nodal agency shall amend the value of Surety Insurance Contract to the extent of balance amount.

The Surety undertakes not to revoke this Surety Contract during its currency, except with the previous express consent of the Nodal Agency in writing and declares and warrants that it has the power to issue this Surety Contract and the undersigned has full powers to do so on behalf of the Surety

In witness where of:

Signature.....
Name: .....

Power of attorney No/ Employee No. as applicable.: ……

For:

……..[Insert Name of the Surety-Insurance Company]
Banker's Seal and Full Address, including mailing address of the Head Office

Notes:

1. The Stamp Paper should be in the name of the Executing Insurance Company.

SCHEDULE: 8B

FORMAT FOR ISSUANCE OF PAYMENT ON ORDER INSTRUMENT

Dear Sir,

1. Indian Renewable Energy Development Agency Limited ('IREDA")/PFC/REC has sanctioned a non-fund based limit loan of Rs. (Rupees..... Only) to M/s. .... [Insert name of SPV or selected Bidder] under the Loan Agreement executed on ..... to execute Transmission System Projects.

2. In consideration of the .....[Insert name of the SPV or Selected Bidder on behalf of SPV or Lead Member in case of the Consortium, with address] for the purposes of this Payment on Order Instrument ("POI") having been selected to undertake the Transmission Project on the terms and conditions contained in the Transmission Service Agreement dated ...../ to be executed as per the draft of the Model Transmission Service Agreement provided along with the Request for Proposal (,,RFP") and other RFP Project Documents, subject to the condition of providing a POI guaranteeing the due performance of the obligations under the Transmission Service Agreement to the Nodal Agency/Central Transmission Utility of India Limited (,,CTUIL"), the.....[Insert name and address of the non-banking financial institutions(IREDA/PFC/REC) issuing the POI and address of the head office] (hereinafter referred to as "Guarantor") hereby agrees unequivocally, irrevocably, absolutely and unconditionally, without demur, to pay to the Nodal Agency at ..... [Insert Place and Address of the Nodal Agency indicated in Transmission Service Agreement, or to the designated Bank Account of the Nodal Agency, namely …….] forthwith on demand in writing from the Nodal Agency, or any Officer authorized by it in this behalf, intimated to the Guarantor at the address mentioned above, any amount as may be decided by the Nodal Agency not exceeding Rupees ..... Crores (Rs) only [Insert the amount of Payment on Order Instrument]

3. At the request of .....and on behalf of M/s. ....., [Insert name of SPV or selected Bidder] this Payment on Order Instrument (POI) for an amount of Rs. ..... (Rupees .....) is being issued with IREDA/PFC/REC assuming the obligations to remit such amount to CTUIL from the sanctioned loan.

4. This Payment on Order Instrument comes into force immediately and IREDA/PFC/REC confirms that it has sufficient amount out of the sanctioned loan and shall maintain the required amount to pay under this Payment on Order Instrument, during the validity and claim period of this Payment on Order Instrument.

5. This POI has been issued by IREDA/PFC/REC utilizing the credit limit of M/s.....[Insert name of SPV or selected Bidder] IREDA/PFC/REC confirms that its liability to pay under this Payment on Order Instrument shall be primary and independent of whether at the time of invocation

of Payment on Order Instrument, the sanctioned funds are available or not and notwithstanding, the status of M/s [Insert name of SPV or selected Bidder] at the relevant time and to whether IREDA/PFC/REC is able to recover the amount advanced by it to the said developer.

6. IREDA/PFC/REC and M/s. …….[Insert name of SPV or selected Bidder] hereby acknowledges, accepts and confirms that this Payment on Order Instrument shall be a Contract of Guarantee as provided under Section 126 of the Indian Contract Act, 1872 and further shall be covered by Section 14(3)(b) of the Insolvency and Bankruptcy Code, 2016 (as amended) shall be enforceable as such.

7. IREDA/PFC/REC liability under this POI is restricted to Rupees Crores (Rs.....) only. This POI shall remain in force until..... [Insert the date of validity of the POI]. The Nodal Agency shall be entitled to invoke this POI up to three hundred sixty-five (365) days after the last date of the validity of this POI. This POI shall be extended from time to time for such period, as may be desired by the TSP.

8. The Guarantor hereby expressly agrees that it shall not require any proof except for the written demand from the Nodal Agency, raised at the above- mentioned address of the Guarantor (address of Guarantor office should be in NCR only) and the Guarantor shall pay the amount to the Nodal Agency without reference to the TSP.

9. Any such demand made by the Nodal Agency on the Guarantor shall be conclusive and binding not withstanding any difference between the Nodal Agency and the TSP or any dispute pending before any Court, Tribunal, Arbitrator or any other authority. The Guarantor undertakes not to revoke this guarantee during its currency without previous consent of the Nodal Agency and further agrees that the POI herein contained shall continue to be enforceable till the Nodal Agency discharges this contract or till the expiry of tenure or (including Claim period) whichever is earlier.

10. The Guarantor shall make payment hereunder within two (02) working days on first demand without restriction or conditions and notwithstanding any objection or disputes raised by the TSP, namely, [Insert name of SPV], or [Insert name of the Selected Bidder], or [Insert name of the TSP] and/or any other person. The Guarantor shall not require the Nodal Agency to justify the invocation of this POI, nor shall the Guarantor have any recourse against the Nodal Agency in respect of any payment made hereunder.

11. This POI shall be interpreted in accordance with the laws of India.

12. The Guarantor represents that this POI Contract has been established in such form and with such content that it is fully enforceable in accordance with its terms as against the Guarantor in the manner provided herein.

13. This POI shall not be affected in any manner by reason of merger, amalgamation, restructuring, liquidation, winding up, dissolution or any other change in the constitution of the Guarantor.

14. This POI Contract shall be a primary obligation of the Guarantor as a Principal to pay on demand by the Nodal Agency and the Nodal Agency shall not be obliged before enforcing this POI Contract to take any action in any court or arbitral proceedings against the TSP, namely, …….[Insert name of SPV], or..... [Insert name of the Selected Bidder], or ..... [Insert name of the TSP] and/or any other person, as the case may be to make any claim against or any demand on the TSP, namely, ... [Insert name of SPV], or ..... [Insert name of the Selected Bidder], or ..... [Insert name of the TSP] and/or any other person, as the case may be, or to give any notice to TSP, namely..... [Insert name of SPV], or ..... [Insert name of the Selected Bidder], or ..... [Insert name of the TSP] and/or any other person, as the case may be, or to enforce any security held by the Nodal Agency or to exercise, levy or enforce any distress, diligence or other process against the TSP, namely, ... [Insert name of SPV], or ……. [Insert name of the Selected Bidder], or ..... [Insert name of the TSP] and/or any other person, as the case may be.

15. The Guarantor acknowledges that this POI Contract is not personal to the Nodal Agency and may be assigned, in whole or in part, (whether absolutely or by way of security) by Nodal Agency to any entity to whom the Nodal Agency is entitled to assign its rights and obligations under the Transmission Service Agreement.

16. The Guarantor hereby agrees and acknowledges that the Nodal Agency shall have a right to invoke this POI Contract either in part or in full, as it may deem fit. In case of invocation of this POI Contract in part, besides making payment for the part of POI Contract invoked, Guarantor at the request of Nodal Agency shall amend the value of POI Contract to the extent of balance amount.

IN WITNESS WHERE OF the non- banking financial institutions through its authorized officer, has set its hand and stamp on this..... day of.....at.....

Signature .....
Name:

Power of attorney No.:
.....For:

..... [Insert Name of the non- banking financial institutions Company]

Seal and Full Address, including mailing address of the Head Office

Schedule: 9

Methodology for determining the Relief Under Force Majeure Event & Change in Law during Construction Period

The relief in the form of revision in tariff due to Force Majeure Event leading to extension of Scheduled COD for a period beyond one hundred eighty (180) days and/ or Change in Law during the construction period shall be as under:

$\Delta T = [(P \times d)] \div [1-(1+ d)^{(-n)}]$

Where,

ΔT = Change in Transmission Charges for each year

P = Sum of cumulative increase or decrease in the cost of the Project due to Change in Law and interest cost during construction corresponding to the period exceeding one hundred eighty (180) due to Force Majeure Event leading to extension of Scheduled COD for a period beyond one hundred eighty (180) days

n = number of years over which the Transmission Charges has to be paid

d = Discount rate as notified by the KERC, applicable on the Bid Deadline, in case KERC notification is not available, then Discount rate shall be as per CERC.

The increase in Transmission Charges as stated above shall be applicable only if the value of increase in Transmission Charges as calculated above exceeds 0.30% (zero point three percent) of the quoted Transmission Charges of the TSP.