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Bhutan Power Corporation Limited
An ISO 9001:2015, ISO 14001:2015 & ISO 45001:2018 Certified Company

(Registered Office: Thimphu)

Distribution Department

Distribution & Customer Services Division

Electricity Services Division



05/BPC/ESD/TG/Tech-01/2024/211

May 01, 2024

NOTICE INVITING TENDER

ESD, BPC, Trashigang invites sealed bids from small Class Bhutanese national Contractors having valid trade licenses and registered with the Construction Development Board (CBD) for the works mentioned below.

Sl. No.	Name of Work	Bid Security (Nu.)	Class	Sale of Document	Date of Submission	Date of Opening
1	Interconnection & Up-gradation (11 kV), and Re-alignment (33 kV) of Medium Voltage Lines	36,895.00 Valid up to August 23, 2024	Small (W4)	May 3, 2024 – May 24, 2024	May 24, 2024 on or before 12:00 Hours	May 24, 2024 14:30 Hours

Interested bidders may purchase the complete set of bidding documents on submission of a written application along with a copy of a valid trade license and CDB registration certificate to the **Chief Divisional Manager, ESD, BPC, Trashigang** on or before 22 May 2024 during office hours. The bidding document can also be downloaded from the BPC website (www.bpc.bt).

The cost of the document is Nu. 1,000.00 (Non-refundable) for hard copy and Nu. 300.00 as a registration fee, for those who download from the website. For registration and any other queries, please contact #17446438/77877282.

Chief Divisional Manager
ESD Trashigang





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DRUK HOLDING & INVESTMENTS LTD.

GROUP STANDARD BIDDING DOCUMENT WORKS



**Interconnection & Up-gradation (11 kV), and
Re-alignment (33 kV) of Medium Voltage
Lines
Electricity Services Division, Trashigang**

Tender No.: 05/BPC/ESD/TG/Tech-01/2024/211/Tender-03

May 2024



TABLE OF CONTENTS

SECTION I – INSTRUCTIONS TO BIDDERS	4
SECTION II – BID DATA SHEET	29
SECTION III – BIDDING FORMS	32
FORM 1: BID SECURITY (BANK GUARANTEE)	32
FORM 2: INTEGRITY PACT STATEMENT	35
FORM 3: BIDDER’S INFORMATION FORM	39
FORM 4: POWER OF ATTORNEY	41
FORM 5: DEVIATION SCHEDULE (IF APPLICABLE)	43
FORM 6: BID SUBMISSION FORM	44
FORM 7: PRICE BILL OF QUANTITIES (ATTACHED)	46
FORM 8: PRICE ADJUSTMENT DATA (NOT APPLICABLE)	49
SECTION IV – GENERAL CONDITION OF CONTRACT	50
SECTION V – SPECIAL CONDITIONS OF CONTRACT	105
SECTION VI – TECHNICAL SPECIFICATIONS	107
SECTION VII - CONTRACT FORMS	108
FORM 1: NOTIFICATION OF AWARD	108
FORM 2: CONTRACT AGREEMENT	109
FORM 3: BANK GUARANTEE FOR CONTRACT PERFORMANCE SECURITY	111
FORM 4: BANK GUARANTEE FOR ADVANCE PAYMENT	113

Detailed Notice Inviting Tender

Bhutan Power Corporation Limited
Distribution Department
Distribution and Customer Services Division
Electricity Services Division
Trashigang: Bhutan
Notice Inviting Tenders (NIT)
(Domestic Competitive Bidding)

For

“Interconnection & Up-gradation (11 kV), and Re-alignment (33 kV) of Medium Voltage Lines”.

NIT No. 05/BPC/ESD/TG/Tech-01/2024/211/Tender-03

May 1, 2024

Electricity Services Division (ESD), Distribution Department (DD), Employer invites sealed Bids from eligible Bidders meeting the qualification requirements for the **“Interconnection & Up-gradation (11 kV), and Re-alignment (33 kV) of Medium Voltage Lines”**.

1.0 As per the scope of work mentioned hereinafter.

2.0 The brief scope of work is as under:

- a) Extension of Medium Voltage Line (11 kV) to interconnect Bidung (Yabrang) feeder and Radhi (Janjanma) feeder :
 - i. Extension of new Medium Voltage lines that interconnect the above-mentioned feeders.
 - ii. Installation of LBS units.
- b) Realignment of Medium Voltage Line (33 kV) between Phugayee and Wakhar:
 - i. Extension of Medium Voltage line from new route.
 - ii. Dismantling of old Medium Voltage Line, rolling and transportation up to road point.
 - iii. Installation of LBS units.

- c) Up-gradation of 11 kV lines from squirrel to Rabbit ACSR from T-off point to 100 kVA Gomchu Substation.
 - i. Dismantling of Squirrel ACSR conductor and, rolling and transportation up to road point.
 - ii. Stringing of new Rabbit ACSR conductor.

3.0 Detailed specifications, scope of work, and terms and conditions are given in the Bidding Documents, which are available at the address given below as per the following schedule:

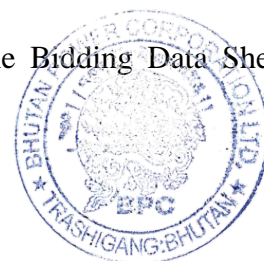
NIT No and name of the work	:	“Interconnection & Up-gradation (11 kV), and Re-alignment (33 kV) of Medium Voltage Lines”.
Estimated Cost of Works	:	Nu. 1.84 million
Bidding Documents shall be available from	:	From 3 May 2024 to 24 May 2024 on all working days From 0900 hours to 1700 hours
Bid receipt date & time	:	May 24, 2024 , on or before 12:00 hours
Bid opening date & time	:	On May 24, 2024 at 14:30 hours at BPC Conference Hall, ESD Trashigang
Bidding Documents shall be available at	:	Office of the Electricity Services Division, DD, BPC, Trashigang www.bpc.bt

4.0 Issuance of bidding documents shall not automatically construe that the Bidder fulfills the Qualifying Requirements, which shall be determined during Bid evaluation based on data/documents submitted by the Bidder. Bids shall be submitted at the address given below and shall be opened in the presence of Bidder’s representatives who choose to attend.

5.0 All Bids must be accompanied by Bid security for an amount of Nu.36,895.00 in the form of Bank Guarantee/ Demand Draft /Cash Warrant, issued/enforceable by any financial institutions in Bhutan, and valid till **August 23, 2024** as shown in the table below. Bids not accompanied with an acceptable Bid security shall be rejected by Employer and in such cases, Bids shall be returned to the Bidders unopened.

6.0 Qualification Requirements for Bidders shall be as specified in the Bidding Data Sheet (BDS).

7.0 Bidding Documents are not transferrable.



8.0 Employer reserves the right to accept or reject any Bid partly or fully or cancel the bidding process without assigning any reasons thereof and in such case no Bidder shall have any claim arising out of such action of Employer.

9.0 The Bidders shall be required to complete the Works within the time for completion as specified in the SCC.

10.0 Address for Communication (Bid Submission):

Chief Divisional Manager
Electricity Services Division, Trashigang
Distribution Department
Bhutan Power Corporation Limited

Phone: +975 (4) 521109

Mobile No.: +975-17962688

esdtgang@bpc.bt / sangaywangdi@bpc.bt



SECTION I – INSTRUCTIONS TO BIDDERS

A. Introduction

1. Definitions and Interpretations

- 1.1. Unless otherwise stated, throughout this Bidding Document definitions and interpretations shall be as prescribed in the General Conditions of Contract.

2. Scope of Works

- 2.1. The scope of Works shall be as specified in Section VI, Technical Specifications or BDS. The name and identification number of the Contract is provided in the NIT.

3. Fraud and Corruption

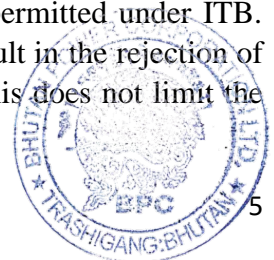
- 3.1. As per the RGoB policy, Employer requires that the Bidders, Contractors and their Subcontractors shall observe the highest standards of ethics during the bidding process and execution of Contracts. The terms “Corrupt practice”, “Fraudulent practice”, “and Collusive practice”, “Coercive practice” and “Obstructive practice” shall be as per the definition in GCC 1.6. In pursuance of this policy, the Employer:
- a) will reject a Bid for award if it determines that the Bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for the Contract in question;
 - b) will sanction a firm or individual, including declaring them ineligible, either indefinitely or for a stated period, to be awarded a contract if it at any time determines that they have, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for, or in executing contract;
 - c) will have the right to require that a provision be included in Bidding Documents and contracts, requiring Bidders, Suppliers, Contractors, and their Subcontractors to permit the Employer, any organization or person appointed by the Employer, and/or any relevant RGoB agency to inspect their accounts and records and other documents relating to the Bid submission and contract performance and to have them audited by auditors appointed by the Employer;

- d) Requires that Bidders, as a condition of admission to eligibility, execute and attach to their bids an Integrity Pact Statement in the form provided in Section III, Bidding Forms. Failure to provide a duly executed Integrity Pact Statement may result in disqualification of the Bid; and
- e) Will report any case of corrupt, fraudulent, collusive, coercive or obstructive practice to the relevant RGoB agencies, including but not limited to the Anti-Corruption Commission (ACC) of Bhutan, for necessary action in accordance with the statutes and provisions of the relevant Agency.

3.2. Furthermore, the Bidders shall be aware of the provisions stated in GCC 1.6.

4. Eligible Bidders

- 4.1. A Bidder shall be an eligible individual, firm, incorporated legal entity or a Joint Venture of such entities under an existing agreement. A Bidder, and all parties constituting the Bidder, shall have the nationality of any country, subject to the restrictions specified in ITB. 4. A Bidder shall be deemed to have the nationality of a country if the Bidder is constituted, incorporated, or registered and operates in conformity with the provisions of the laws of that country. This criterion shall also apply to the determination of the nationality of the proposed subcontractors for any part of the Contract.
- 4.2. A Bidder shall not have a conflict of interest. Any Bidder, found to have a conflict of interest, shall be disqualified. Bidders may be considered to have a conflict of interest with one or more parties in the same bidding process if they:
 - a) or any of their affiliates are associated, or have been associated in the past, to provide consulting services for the preparation of the design, specifications, and/or other documents to be used for the procurement of the Works to be executed according to these Bidding Documents, or in any other way provided the consulting services in any aspect of the preparatory stages leading up to the issue of these bidding documents or hired/ proposed to be hired by Employer as Project Manager for the Contract implementation;
 - b) Submit more than one Bid in this bidding process either individually or as a partner in the Joint Venture, except for alternative offers permitted under ITB. 15. Participation by a Bidder in more than one Bid shall result in the rejection of all Bids in which the Bidder has participated. However, this does not limit the



participation of a Bidder as a Subcontractor in another Bid or more than one Bid;

- c) employ or otherwise engage, either directly or through any of their Affiliates, an Employer-employee, spouse or any of the dependent parent of an Employer-employee;
- d) have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the Bid of another Bidder, or influence the decisions of the Employer regarding this bidding process; or
- e) Have the same legally authorized representative for purposes of this Bid.

- 4.3. An Employer formed by the merger of two or more companies or divisions of such companies engaged in the execution of Works as specified in the Bidding Documents can also participate provided the constituent companies or divisions before the merger individually or jointly meet the stipulated qualification requirements fully.
- 4.4. If so, specified in the BDS, if a foreign/expatriate Bidder, who is currently not doing business within the Kingdom of Bhutan, is awarded the contract, the Bidder may be represented by an agent in the Kingdom of Bhutan. The agent shall be a legal entity, equipped and able to carry out the Contractor's obligations.
- 4.5. Where an agent is permitted to submit the Bid on behalf of the Foreign Bidder, payment of agency commission, if any, to the Foreign Bidder shall only be made in the local currency. The agent and the Foreign Bidder shall not be permitted to submit separate bids in the same bidding process. On the other hand, an agent shall not be allowed to work with and represent more than one party/Bidder.
- 4.6. In the case of JVs with any of the Bhutanese Bidder, the payment to the Bhutanese member of the JV for the services from within Bhutan shall be in local currency.
- 4.7. The Bidder shall provide such evidence of their continued eligibility satisfactory to the Employer, as the Employer shall reasonably request.

5. Exclusion of Bidders

- 5.1. A Bidder shall be ineligible for participating in this bidding process under the following circumstances:



- a) The Bidders is insolvent or is in receivership or is bankrupt is in the process of being wound up; or has entered into an arrangement with the creditors; or
- b) The Bidders' affairs are being administered by a court, judicial officer or appointed liquidator; or
- c) The Bidder has suspended business or is in any analogous situation arising from similar procedures under the laws and regulations of his country of establishment; or
- d) The Bidder has been found guilty of professional misconduct by any competent authority as per law or any professional body; or
- e) The Bidder has not fulfilled his obligations with regard to the payment of taxes, social security or other payments due in accordance with the laws of the country in which he is established or of the Kingdom of Bhutan; or
- f) The Bidder has been declared by Employer or the Anti-Corruption Commission to be ineligible for participation in tenders on account of any fraud and/or corruption in competing or executing a Contract; or
- g) The Bidder has been debarred/blacklisted from participation in public procurement by any competent authority as per law; or
- h) As a matter of law or official regulation, the Royal Government of Bhutan (RGoB) prohibits commercial relations with the country of the Bidder. Such exception shall be specified in the BDS.

6. Joint Venture Bids

6.1. Bids submitted by a joint venture, if so, permitted in the BDS, formed by several legal entities as specified in the BDS subject to the condition that the total number of legal entities shall not exceed three (3) entities, shall comply with the following requirements:

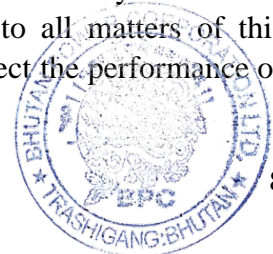
- a) The Bid shall be signed by an authorized signatory of the joint venture, who has been authorized by all the other members so that the bid is legally binding on all members;



- b) One of the partners shall be designated as a leader who shall have the authority to conduct all business for and on behalf of any members of the joint venture. This authorization shall be evidenced by submitting with the bid a power of attorney signed by legally authorized signatories of the other members;
 - c) The leader shall be authorized to receive instructions for and on behalf of any and all members of the Joint Venture and the entire execution of the contract, including payment, shall be done exclusively with the leader;
 - d) All members of the joint venture shall be liable jointly and severally for the execution of the contract in accordance with its terms; and
 - e) A copy of the agreement entered into by the joint venture members as per the format provided in the bidding documents shall be submitted with the Bid. In order for JV to qualify, either the lead partner must meet the minimum technical qualification requirements or can be met jointly by the JV partners, as specified in the BDS.
- 6.2. The financial qualification requirements however may be met jointly by the members of the JV subject to the condition that each member can independently meet at least the minimum financial qualification requirements as specified in the BDS. Failure to comply with this requirement will result in rejection of the Joint Venture's Bid.
- 6.3. A firm can be a member in only one joint venture; bids submitted by joint ventures including the same firm as member in more than one JV in the same bidding process shall be rejected.

7. Responsibility of Bidders

- 7.1. Employer shall not assume any responsibility regarding information gathered, interpretations or conclusions made by the Bidder or regarding information, interpretations or deductions the Bidder may derive from the data or any report furnished by Employer. Verbal communication or conversation with any employee of Employer either before or after the submission of the Bid shall not affect or modify any of the terms or obligations contained herein.
- 7.2. It shall be the sole responsibility of Bidders to determine and to satisfy themselves by such means as they consider necessary or desirable as to all matters of this bidding process including in particular all factors that may affect the performance of the Contract in the event of award.



B. The Bidding Documents

8. Contents of Bidding Documents

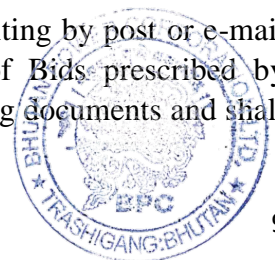
- 8.1. The bidding document includes the sections stated below together with any addendum/amendment to be issued in accordance with ITB. 12.

Section I	Instructions to Bidders (ITB)
Section II	Bid Data Sheet (BDS)
Section III	Bidding Forms
Section IV	General Conditions of Contract
Section V	Special Conditions of Contract
Section VI	Technical Specifications
Section VII	Contract Forms

- 8.2. The Bidder is expected to examine all instructions, forms, terms, conditions, specifications and other information in the bidding documents and shall be deemed to have carefully examined the bidding documents and also to have satisfied himself as to the nature, character and scope of work to be executed. Failure to furnish all information and documents required as per the Bidding Documents or submission of a Bid not substantially responsive to the Bidding Documents in every respect shall be at the Bidder's risk and may result in rejection of his bid.

9. Clarifications on Bidding Documents

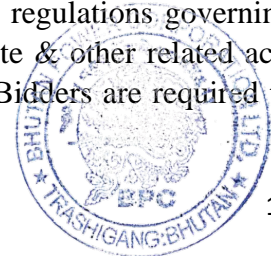
- 9.1. The Bidder shall examine the bidding documents thoroughly in all respects and if any conflict, discrepancy, error or omission is observed, the Bidder may request clarification promptly. A prospective Bidder requiring any clarification on the bidding documents may notify Employer in writing by post or e-mail, to the address mentioned in BDS, not later than the date and time specified in BDS.
- 9.2. Employer shall issue clarification(s) as it may think fit in writing by post or e-mail prior to the deadline/ extended deadline for submission of Bids prescribed by Employer. All such clarifications shall form part of the bidding documents and shall accompany the Bidder's bid.



- 9.3. For the information of all Bidders, the clarifications shall also be uploaded on the Employer's and/or relevant website. The Bidders are advised to visit the website of the Employer from time to time in their interest.
- 9.4. Bidders shall not be allowed to seek any clarification on the bidding documents in person or by telephone or other verbal means. Any queries sent by the Bidders after the date and time notified in the BDS or extended date, if any, shall not be entertained.
- 9.5. Should Employer deem it necessary to amend the bidding documents as a result of a clarification, it shall do so following the procedure under ITB. 12.
- 9.6. Any failure on the part of the Bidder to comply with the provisions under ITB 9 shall not excuse him/her for performing the works in accordance with the contract, in case of award.

10. Site Visit and Familiarization

- 10.1. The Bidder is advised to visit and examine the site and its surroundings where the Works are to be executed and obtain for itself on its responsibility and risk, all information that may be necessary for preparing the Bid and entering into a Contract for execution of the Works. The costs of visiting the site shall be fully borne by the Bidder. Employer shall facilitate the site visit and Bidder is required to furnish advance intimation of his site visit.
- 10.2. The Bidder shall acquaint himself with the adequacy of local conditions and requirements including the approach roads to the site, adequacy of existing culverts, bridges, and roads for the expected traffic, water and power supply, nature of ground and sub-soil conditions, water table level, river regime, river water levels, and other details, geological and climatic conditions, local terrain, availability of labour and construction material, communication facilities, utility and labour conditions and shall not claim at any time after submission of the Bid or during the execution of the Contract that there was any lack of understanding about the conditions imposed in the Contract or prevailing at the site.
- 10.3. In their own interest, the Bidders are required to familiarize themselves with the Income Tax Act, prevailing labour laws including laws and regulations governing engagement of labour for employment and deployment at site & other related acts and laws prevalent in the Kingdom of Bhutan. Further, the Bidders are required to



comply with these acts/laws and other relevant provisions, particularly with reference to the execution of the works.

- 10.4. Foreign Bidders shall familiarize themselves especially with the rules and regulation applicable to the foreign firms for carrying out business in the Kingdom of Bhutan.

11. Pre-Bid Meeting

- 11.1. A pre-bid meeting shall be conducted only if necessary to clarify doubts and concerns of the Bidders prior to submission of bids. The Bidders who have downloaded the bidding documents from the Employer's /relevant website shall attend a pre-bid meeting to be held on the date, time, and location specified in BDS.
- 11.2. Non-attendance at the pre-bid meeting shall not be a cause for disqualification of Bidders but at the same time shall not entitle them to raise any query at a later date.
- 11.3. Minutes of the pre-bid meeting, including the text of the questions raised without identifying the source, and the responses given together with any responses prepared after the meeting, shall be circulated to all Bidders who have downloaded the bidding documents.
- 11.4. Any modification to the bidding documents that may become necessary as a result of the pre bid meeting shall be made by Employer through the issue of an addendum pursuant to ITB. 12.

12. Amendment of Bidding Documents

- 12.1. At any time before the deadline for submission of Bids, the Employer may amend the bidding documents by issuing an addendum/ corrigendum. This may be done either on the Employer's initiative or in response to clarification requests from any prospective Bidder.
- 12.2. The addendum/corrigendum shall be sent in writing either by post/ e-mail to all prospective Bidders. For the information of other Bidders, the addendum/amendments/corrigendum shall also be uploaded on the Employer/relevant website.
- 12.3. An employer shall assume that the information contained therein has been taken into account by the Bidder in its Bid and shall bear no responsibility or liability arising out of non-receipt of the same in time or otherwise by the Bidder.

- 12.4. Employer may, at its discretion, extend the deadline for submission of Bids pursuant to ITB. 25.2 to allow prospective Bidders reasonable time to take the addendum into account in preparation for their Bids. It would be in the interest of the Bidders to regularly visit the Employer's website for information on any amendment or clarification to the bidding documents. An employer shall in no way be responsible for any ignorance of the Bidder about the amendment to the bidding documents.

C. Preparation and Submission of Bids

13. Cost of Bidding

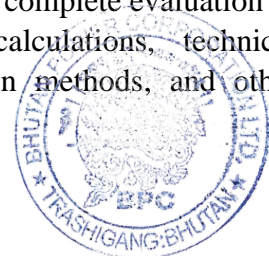
- 13.1. The Bidder shall bear all costs, direct or indirect associated with the preparation and submission of his bid (including site visits and attending pre-bid meetings), and the Employer in no case shall be responsible or liable for these costs, regardless of the conduct or outcome of the bidding process.

14. Language of Bid

- 14.1. The Bid and all correspondence and documents related to the Bid shall be in English. Supporting documents and printed literature provided by the Bidder related to the Bid shall also be in English and if in any other language, should be translated to English. The English translation shall prevail on the interpretation.

15. Alternative Bids

- 15.1. Alternative bids shall not be considered unless specifically allowed in the BDS. If so allowed, ITB. 15.1 and ITB. 15.2 shall govern, and the BDS shall specify which of the following options shall be allowed:
- a) Option One: A Bidder may submit alternative bids with his base bid and the Employer shall only consider the alternative bids offered by the Bidder whose bid for the base case was determined to be the lowest-evaluated bid, or
 - b) Option Two: A Bidder may submit an alternative bid with or without a bid for the base case. All bids received for the base case, as well as alternative bids meeting the Technical Specifications pursuant to Section VI, shall be evaluated on their own merits.
- 15.2. Alternative bids shall provide all information necessary for a complete evaluation of the alternative by the Employer, including design calculations, technical specifications, breakdown of prices, proposed construction methods, and other relevant details.



16. Documents Constituting the Bid

16.1. The Bid shall comprise the following documents:

- a) Bid submission forms and Bill of Quantities;
- b) Bid Security in accordance with ITB. 22;
- c) Integrity Pact Statement duly executed by the bidder, as per Form: 2 of Section III;
- d) Relevant bidding forms;
- e) Power of Attorney;
- f) Documentary evidence establishing Bidder's Qualification stipulated in BDS;
- g) Deviations sheet in accordance with bidding Form: 5 of Section III. No deviation, whatsoever, shall be permitted by Employer, to the provisions of the Bidding Documents listed in the BDS;
- h) Alternative Bids if permitted in the BDS; or
- i) Any other documents required in the BDS.

17. Bid Submission Forms

- 17.1. The Bidder shall submit the bid using the Bid Submission Form prescribed under Form: 6 of Section III. This form must be completed without any alterations to its text, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.
- 17.2. A bid in which the Bid Submission Form is not duly filled, signed, and/or sealed by the bidder shall be rejected.

18. Bid Prices and Discounts

- 18.1. The Bidder shall fill in unit rates/ prices for all items of the Works described in the BoQ in figures. The unit rates/ prices quoted in the BoQ shall also be deemed to include any incidentals not shown or specified but reasonably implied or necessary for the proper completion and functioning of the whole specified item of the Works in accordance with the Bidding Documents and shall also deem to include the cost of construction of infrastructural facilities required for the execution of the Contract and not included in the Works. The Contract shall be for the whole Works based on the unit rates and prices in the Priced BoQ submitted by the Bidder.
- 18.2. The unit rates/ prices quoted in the BoQ shall be inclusive of all taxes, duties, levies & charges payable in the Kingdom of Bhutan (including those levied on the

construction material quarried from land owned by Employer or otherwise), as of thirty (30 days) days prior to the deadline for submission of Bids.

- 18.3. The total price at the bottom of the Priced BoQ shall be indicated both in figures and words.
- 18.4. If a rebate/discount is offered, the overall discount in percentage shall be brought out in the Priced BoQ. Conditional rebates/discounts, if any, offered by any Bidder shall not be considered during Bid evaluation.
- 18.5. The prices and discounts quoted by the Bidder in the Bid Submission Form and the Priced BoQ shall conform to the requirements specified below:
- a) Items for which no rate or price is entered by the Bidder in the Priced BoQ shall not be paid by the Employer when executed and shall be deemed covered by the other rates and prices mentioned in the Priced BoQ.

19. Contract Price Adjustment

- 19.1. Prices quoted by the Bidder shall be fixed during the Bidder's performance of the Contract or subject to variation, as specified in the BDS. A Bid submitted with an adjustable price quotation shall be treated as non-responsive and shall be rejected under ITB. 31 unless adjustable price quotations are permitted.
- 19.2. If, in accordance with the BDS, prices quoted by the Bidder are subject to adjustment during the performance of the Contract:
- a) The prices quoted by the Bidder shall reflect changes in the cost of labour, material, etc. in accordance with the procedures specified in GCC.12.1
 - b) A Bid submitted with a fixed price quotation when Bids have been invited with price variation, will not be rejected, but the price adjustment will be treated as zero.
 - c) The estimated effect of the price adjustment provision applied over the period of execution of the Contract shall not be taken into consideration in Bid evaluation.
 - d) Employer shall indicate the name, source, and origin of indices along with their base values and corresponding coefficients as per SCC.



20. Currencies of Bid

- 20.1. The unit rates and prices shall be quoted by the Bidder in any of the currency (ies) specified in the BDS.
- 20.2. The reference exchange rate (selling rate) prevailing on the day of Bid opening or the immediately preceding date as posted by the Royal Monetary Authority of the Kingdom of Bhutan shall be used for the conversion of prices.
- 20.3. The payment to the Contractor shall be made in the currency of Bid and any banking charges related to payment shall be borne by the Contractor.

21. Period of Validity of Bids

- 21.1. Bids shall remain valid till the date specified in the BDS. A Bid valid for a shorter period shall be liable for rejection by the Employer as non-responsive.
- 21.2. In exceptional circumstances, prior to the expiry of the Bid validity period, the Employer may request Bidders to extend the period of validity of their Bids. The request and the responses shall be made in writing to all the participating Bidders. A Bidder may refuse the request to extend the validity of its Bid without forfeiting its Bid Security. In such a case, the Bid of the Bidder, refusing to extend the validity of its Bid, shall not be considered for evaluation and award. A Bidder granting the request shall be required to extend the validity of their Bid securities correspondingly but shall not be required or permitted to modify its Bid.
- 21.3. The provisions of ITB 22 regarding discharge and forfeiture of Bid Security shall continue to apply during the extended period of Bid validity.

22. Bid Security

- 22.1. The Bidder shall furnish, as part of its Bid, a Bid Security in original form, denominated in the currency and the amount specified in the BDS.
- 22.2. The Bid Security shall at the Bidder's option, be in any forms stipulated in the BDS:
- a) An unconditional and irrevocable Bank Guarantee as per the form; or
 - b) A Banker's Cheque/ Cash Warrant; or
 - c) A Demand Draft; or
 - d) Cash deposit in the Employer's bank account, only in case of exceptional circumstances.

- 22.3. Bid Security shall be issued by a reputable financial institution enforceable in any Bank in Bhutan;
- 22.4. Bid security shall be in its original form and copies shall not be accepted. Bid Security shall be valid for thirty (30) days beyond the bid validity period, as extended, if applicable, in accordance with ITB. 21.2. Accordingly, the Bid security shall remain valid till the date specified in the BDS;
- 22.5. Any Bid not accompanied by adequate Bid Security shall be rejected by the Employer as non-responsive.
- 22.6. Return of Bid Security:
- a) The Bid Securities of unsuccessful Bidders shall be returned as promptly as possible upon the successful Bidder furnishing the Performance Security according to ITB. 40 and signing the Contract.
 - b) In case of single-stage – two-envelope and two-stage modes of tendering, Bid Security of non-responsive Bidders shall be returned immediately after technical evaluation.
- 22.7. The Bid Security shall be forfeited:
- a) if a Bidder withdraws its Bid as a whole or in part during the Bid validity period; or
 - b) if the Bidder has been found practicing corrupt or fraudulent or collusive or coercive practices during the bidding process; or
 - c) If the successful Bidder fails to:
 - i. Accept the correction of its Bid Price pursuant to ITB. 32;
 - ii. sign the Contract in accordance with ITB 41; or
 - iii. Furnish a Performance Security in accordance with ITB 40.
- 22.8. The Bid Security of a JV/C must be in the name of the JV/C that submits the Bid.

23. Signing of Bids

- 23.1. The Bidder shall prepare ONE Original of the documents comprising the Bid as described in ITB Clause 18 and mark it “ORIGINAL”. In addition, the Bidder shall submit copies of the Bid, in the number specified in the BDS and mark them “COPY”. In the event of any discrepancy between the original and the copies, the original shall prevail.
- 23.2. The original and all copies shall be typed or written in indelible ink and shall be signed by a person/persons duly authorized by the Bidder with official seal as per Form: 4 of Section III. However, any published document submitted along with the Bid shall be signed by the authorized signatory (i.es) at least on the first page and last page of such document.
- 23.3. Any interlineations, erasures, overwriting, cutting, or alteration shall only be valid if they are initialed by the authorized signatory (i.es) to the Bid.

24. Submission of Bids

- 24.1. Each Bidder, including its affiliate, shall be permitted to submit only one Bid against a particular NIT. In case a Bidder and its affiliate have submitted separate Bids against the same NIT, such bids shall be rejected.
- 24.2. Bids shall be delivered by hand, courier registered post, or electronic means to reach Employer at the address specified in BDS on or before the date and time mentioned in BDS. An employer shall not be responsible for any delay in receipt of the bid sent by post or courier.
- 24.3. In case of hand delivery, Bids shall be handed over to the Nodal officer at the address as specified in BDS.
- 24.4. The Bids shall be submitted in envelopes, signed and sealed in the manner stipulated hereunder or as mentioned in the BDS. The outer Envelope shall:
- a) be marked “CONFIDENTIAL”;
 - b) be addressed to the Employer provided in the BDS;
 - c) bear the Tender name and number; and
 - d) Provide a warning not to open before the time and date for Bid Opening.
- 24.5. Single-Stage Two Envelope Process:



- a) The inner Envelope- I shall contain:
 - i. Technical bids and be signed across their seals by the person authorized to sign the Bid on behalf of the Bidder; and
 - ii. Be marked “ORIGINAL”, “ALTERNATIVE” (if permitted), and “COPY”
 - b) The inner envelope –II shall contain:
 - i. Financial bids and be signed across their seals by the person authorized to sign the Bid on behalf of the Bidder; and
 - ii. Be marked “ORIGINAL”, “ALTERNATIVE” (if permitted), and “COPY”.
- 24.6. Where bids are invited under the single stage single envelope, both technical and financial bids shall be in one envelope.
- 24.7. In addition to the identification required in ITB. 24.4, the inner envelopes shall indicate the name and address of the bidder, to enable the bid to be returned unopened in case it is declared late pursuant to ITB. 26.
- 24.8. If the outer envelope is not sealed and marked as above, the Employer shall assume no responsibility for the misplacement or premature opening of the bid.
- 24.9. In the two-stage process, bidders shall be advised to submit only the technical bids in the first stage. In the second stage, bidders shall be requested to submit both their technical bids as modified and agreed with the Employer and the financial bids based on the modified technical bids simultaneously in two separate sealed envelopes.
- 24.10. When so specified in the BDS, Bidders shall have the option of submitting their Bids electronically. Bidders submitting Bids electronically shall follow the procedures specified in the BDS.

25. Deadline for Submission of Bids

- 25.1. Bids must be received by the Employer in accordance with ITB. 24. In the event of the specified date for submission of Bids being declared a holiday for the Employer,



the Bids shall be received up to the specified time on the next working day. Such postponement of the date shall not have any impact on the other dates specified in the Bidding Documents (i.e., bid validity and validity of bid security).

- 25.2. An employer may, at its discretion, extend the deadline for the submission of Bids/ opening of Bids by issuing an addendum and hosting the same on the website, in which case all rights and obligations of the Employer and the Bidders previously subject to the original deadline shall thereafter be subject to the deadline as extended.
- 25.3. In the event of the deadline for submission of the Bid extended by the Employer, the Bidders who have already submitted their Bids within the original deadline of submission shall have the option to submit their revised Bid in substitution either in full or in part of the earlier Bid. In the absence of a revised Bid, the original Bid shall be considered for opening and subsequent evaluation if otherwise in order. Wherever the Bidder has submitted the revised Bid in modification of the earlier Bid, the earlier Bid shall be returned unopened to the Bidder.

26. Late Bids

- 26.1. Any Bid received by the Employer after the bid submission deadline shall be declared late, rejected, and returned unopened to the Bidder.

27. Withdrawal, Substitution, or Modification of Bids

- 27.1. A Bidder may withdraw, substitute, or modify its Bid after it has been submitted by sending a written withdrawal/ substitution/ modification notice before the deadline for submission of Bids, duly signed by an authorized representative, including a copy of the authorization, Power of Attorney as per Form: 4 of Section III. The bid requested to be withdrawn shall be returned unopened to the Bidder.
- 27.2. The substitution or modification of the Bid must accompany the respective written notice and must be:
- a) Submitted in accordance with ITB. 26 and, in addition, the respective cover envelopes shall be clearly marked “SUBSTITUTION” or “MODIFICATION;” and
 - b) Received by Employer prior to the deadline prescribed for submission of Bids, in accordance with ITB. 24.

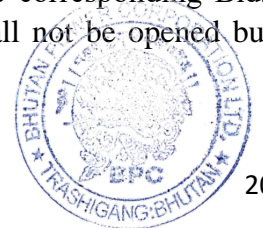


- 27.3. No Bid may be withdrawn, substituted or modified in the interval between the deadline for submission of Bids and the expiry of the period of bid validity specified in the BDS or any extension thereof pursuant to 21.2.
- 27.4. Withdrawal, substitution, or modification of a Bid between the deadline for submission of Bids and the expiry of the period of bid validity (or any extension thereto) shall result in the forfeiture of the bid security pursuant to ITB.24.5.
- 27.5. If the lowest evaluated Bidder withdraws his Bid between the periods specified pursuant to ITB.29.4, the bid security of the Bidder shall be forfeited.

D. Bid Opening, Evaluation, and Comparison

28. Bid Opening

- 28.1. An employer shall conduct the bid opening at the address, date, and time specified in the BDS. Any specific electronic bid opening procedures required if electronic bidding is permitted shall be as specified in the BDS.
- 28.2. Bidders or their authorized representatives (not more than two) shall be allowed to attend the bid opening. Bidders who choose to attend shall sign the attendance sheet provided in the record of Bid opening with their name, designation, firm name, and phone number or any other particulars as may be required. Bidders who choose to attend the opening shall not be allowed to speak on matters related to the Bid until and unless required by the committee members or by seeking permission from the Chairperson by raising a hand. Bidders who have any complaint with regard to the Bid opening shall write in the complaint sheet and duly sign the sheet.
- 28.3. The written withdrawal notices duly signed by an authorized representative of the Bidder for withdrawal of Bids, if any, shall be opened first and read out and such Bids shall be returned to the Bidder unopened.
- 28.4. The written substitution/ modification notices duly signed by an authorized representative of the Bidder in accordance with ITB. 27.1 shall be opened and read out and the corresponding cover envelopes, which are marked “SUBSTITUTION”/ “MODIFICATION” shall be opened and exchanged with the corresponding Bids being substituted/modified. The substituted/modified bids shall not be opened but returned to the Bidder.



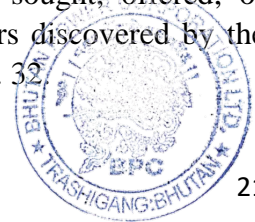
- 28.5. Cover envelopes of all other Bids shall be opened one at a time. Bids not accompanied by requisite Bid Security, or other documents and information as detailed in ITB. 16 shall be rejected and returned to the Bidder.
- 28.6. The Bidders' representatives who are present shall be requested to sign the record. The omission of a Bidder's representative's signature on the record shall not invalidate the contents and effect of the record.
- 28.7. In the case of Single Stage Two Envelope Bids, the technical bid shall be opened on the bid opening date. The date for opening the Financial Bid shall be intimated to the Bidders whose Bid is found responsive in the techno-commercial evaluation.

29. Confidentiality

- 29.1. Information relating to the examination, evaluation, comparison of Bids, and recommendation of Contract Award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until publication of the Contract Award.
- 29.2. Any effort by a Bidder to influence the Employer in the examination, evaluation, comparison, and post-qualification of the Bids or Contract Award decisions may result in the rejection of its Bid.
- 29.3. Notwithstanding ITB 29, from the time of Bid Opening to the time of Contract Award, if any Bidder wishes to contact the Employer on any matter related to the bidding process, it should do so in writing.

30. Clarification of Bids

- 30.1. To assist in the examination, evaluation, comparison, and post-qualification of the Bids, the Employer may, at its discretion, ask any Bidder for a clarification on its Bid including justification and breakup of the rates and prices quoted. Any clarification submitted by a Bidder that is not in response to a request by an Employer shall not be considered. Employer's request for clarification and the response thereto shall be in writing and shall be delivered by email/post/hand delivery.
- 30.2. No change in the prices or substance of the Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids, in accordance with ITB. 32

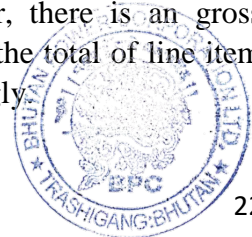


31. Preliminary examinations of Bids and determination of responsiveness

- 31.1. The Employer shall examine the Bids to confirm that all documents and information requested in ITB 16 have been provided and to determine the completeness of each document submitted.
- 31.2. Prior to the detailed evaluation of bids, the Employer shall determine whether each bid (a) meets the eligibility criteria defined in ITB 4; (b) has been properly signed; (c) is accompanied by the Bid Security; and (d) is substantially responsive to the requirements of the bidding documents.
- 31.3. A substantially responsive bid conforms to all the terms, conditions, and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the Bidding Documents, the Employer's rights or the Bidder's obligations under the Contract; or (c) whose rectification would affect unfairly the competitive position of other Bidders presenting substantially responsive Bids.
- 31.4. If a Bid is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation.

32. Correction of Arithmetical Errors in Price Bid

- 32.1. Arithmetical errors shall be corrected at the time of evaluation of Price Bid and the corrected figure shall be considered for evaluated bid price. The corrections in the bid price shall be done as per the provisions of this clause and shall be binding on the Bidder. If the Bidder does not accept the correction of errors as per the provisions of this clause, the bid shall be rejected and the bid security shall be forfeited.
- 32.2. If there is a discrepancy between the product of unit price & quantity and the total price for such item, the product of unit price and quantity shall prevail and the total price shall be corrected unless, in the opinion of Employer, there is an gross misplacement of decimal point in the unit rate, in which case, the total of line item as quoted shall prevail and unit rate shall be corrected accordingly.



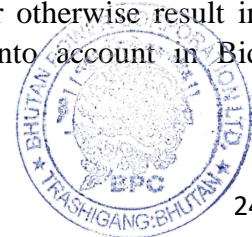
- 32.3. If there is a discrepancy between the summation of subtotals and the total price, the summation of the subtotal price shall prevail, and the total price shall be corrected.
- 32.4. If there is a discrepancy between words and figures, wherever the bid document requires the figures to be written in words and figures, the amount in words shall prevail unless the amount expressed in words has an arithmetic error.
- 32.5. In case the Bidder has not quoted unit price against any item, the Employer shall treat the price of unquoted items as zero for evaluation, comparison, and award, with the assumption that the costs have been absorbed elsewhere in the Price Bid. If such a Bidder emerges as the successful Bidder, he shall be awarded the contract without any price/rate for the concerned items.
- 32.6. In case prices for some items are given by a Bidder as lump sum where unit rates are required, the Employer reserves the right to arrive at the unit rate based on dividing the entered lump sum amount by the specified quantity.

33. Detail Evaluation and Comparison of Bids

- 33.1. The Employer shall evaluate each Bid that has been determined, up to this stage of the evaluation, to be substantially responsive. To evaluate a Bid, the Employer shall only use the factors, methodologies, and criteria defined in ITB 33. No other criteria or methodology shall be permitted.
- 33.2. To evaluate and compare Bids, the Employer shall consider the following:
- a) The final bid price, as quoted in accordance with ITB. 18 in the priced BoQ;
 - b) Price adjustment for correction of arithmetic errors in accordance with ITB. 32;
 - c) Price adjustment due to discounts offered in accordance with ITB. 18;
 - d) The cost of withdrawal of declared deviations as per Form: 5 of Section III and in accordance with ITB. 33.4;
 - e) adjustments due to the application of the evaluation criteria specified in the BDS or those set out in the Evaluation and Qualification Criteria uploaded in the Employer's/relevant website; and



- f) Adjustment due to the application of a margin of preference, in accordance with ITB 34, if applicable.
- 33.3. Employer's evaluation of a bid shall exclude and not take into account any allowance for price adjustment during the period of execution of the contract if provided in the Bid.
- 33.4. The evaluation shall be based on the evaluated cost of fulfilling the Contract in compliance with all commercial, contractual, and technical obligations under the Bidding Documents. In arriving at the evaluated cost, the price for withdrawal of deviations shown in Form: 5 of Section III of the bid shall be used. Where necessary, if the cost of the withdrawal of any deviation is not given in Form: 5 of Section III, the Employer shall make its assessment of the cost of such a deviation to ensure a fair comparison of Bids.
- 33.5. For comparison, the total price offered by Bidders shall be calculated based on ITB. 33. Employer shall compare the total price offered by all substantially responsive bids of qualified Bidders to determine the lowest evaluated Bid.
- 33.6. If the lowest evaluated Bid appears abnormally low and/or seriously unbalanced, the Employer may require the Bidder to produce written explanations of justifications and detailed price analysis for any or all items of the Bill of Quantities to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. Abnormally low Bids may or may not be accepted. If the Employer decides to accept the abnormally low Bid /or the Bid with seriously unbalanced rates after considering the above, the Bidder shall be required to provide additional differential security in addition to the performance security, an equivalent to the difference between the estimated and quoted price to a maximum of (ten percent) 10% of the quoted price, to protect Employer against any financial loss in the event of default of the successful Bidder under the Contract. If the lowest evaluated Bid is abnormally high at the discretion of the Employer, then the Employer may seek justification for the high rates and if necessary, negotiate with the lowest evaluated Bidder and may reject the bid if considered to be abnormally higher than the estimate.
- 33.7. Employer reserves the right to accept or reject any variation, deviation, or alternative offer. Variations, deviations or alternative offers, and other factors that are more than the requirements of the Bidding Documents or otherwise result in unsolicited benefits for the Employer shall not be taken into account in Bid evaluation.



34. Margin of preference

- 34.1. If specified in the BDS, domestic Contractors may receive a margin of preference during evaluation, for which this clause shall apply.
- 34.2. A domestic Bidder shall provide all evidence necessary to prove that it meets the following criteria to be eligible for a margin of preference in the comparison of its Bid with those Bidders who do not qualify for the preference. A domestic Bidder shall:
- a) be registered within Bhutan, constituted under and governed by the civil, commercial, or public law of Bhutan, and have its statutory office, central administration, or principal place of business there;
 - b) have majority ownership by nationals of Bhutan;
 - c) not subcontract more than twenty percent (20 %) of the initial Contract Price, excluding provisional sums, to foreign contractors, suppliers, and/or consultants.
- 34.3. Joint Ventures, Consortia, and Associations of domestic firms may be eligible for the margin of preference provided that:
- a) the individual partners satisfy the criteria of eligibility of ITB 34.2 (a) and (b);
 - b) the JV/C/A is registered in Bhutan;
 - c) the JV/C/A does not subcontract more than ten percent (10 %) of the initial Contract Price, excluding provisional sums, to foreign firms; and
 - d) the JV/C/A satisfies any other criteria specified for domestic preference eligibility, as specified in the BDS.
- 34.4. The procedure used to apply the margin of preference shall be as stipulated in the BDS.

35. Subcontracting

- 35.1. Unless otherwise stated in the BDS, the Employer does not intend to execute any specific elements of the Works by subcontractors. If permitted, Bidders may propose subcontracting for part of the works as specified in the BDS.

36. Employer's Right to Accept Any Bid and to Reject Any or All Bids



- 36.1. Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids at any time before contract award, without thereby incurring any liability to Bidders or any obligation to inform the affected Bidders of the grounds for such action of the Employer.

E. Award of Contract

37. Award Criteria

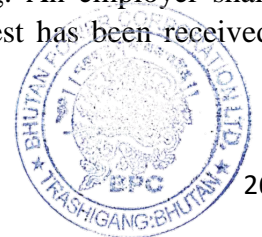
- 37.1. An employer shall award the Contract to the successful Bidder whose bid has been determined to be substantially responsive and to be the lowest evaluated Bid, further, provided that the Bidder is determined to be eligible and qualified and has the capacity and capability to fulfill the contract following relevant provisions of the bidding document.

38. Notification of Award

- 38.1. Prior to the expiry of the period of bid validity, Employer shall notify the successful Bidder, through a Notification of Award (NoA) as per Form: 1 of Section VII in writing, that its bid has been accepted indicating the award price. The successful bidder shall return a copy of the Notification of Award to Employer after duly recording “Accepted Unconditionally” under the signature of the authorized signatory within seven (7) days of the date of notification of award.
- 38.2. Until a formal contract is prepared and executed, the NoA shall constitute a binding contract between the successful Bidder and Employer.
- 38.3. Upon the furnishing of performance security pursuant to ITB.40 by the successful Bidder, Employer shall:
- a) Promptly notify each unsuccessful Bidder and return their bid security; and
 - b) Publish a notification of the award on its website.

39. Debriefing by Employer

- 39.1. On receipt of Notification of Award, an unsuccessful Bidder has three (3) working days to make a written request to Employer for a debriefing. An employer shall provide a debriefing to all unsuccessful Bidders whose request has been received within this deadline.



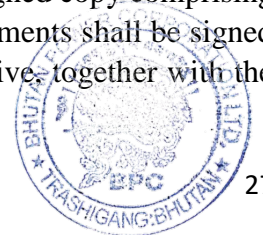
- 39.2. Where a request for debriefing has been received within the deadline, Employer shall provide a debriefing within five (5) working days.
- 39.3. An employer shall discuss only such Bids and not the bids of other competitors. The debriefing shall not include:
- a) point-by-point comparisons with another Bid; and
 - b) information that is confidential or commercially sensitive to other Bidders.
- 39.4. The purpose of debriefing is to inform the aggrieved Bidder of the reasons for the lack of success, pointing out the specific shortcomings in its bid without disclosing the contents of other bids.

40. Performance Security

- 40.1. Within seven days (7) days after receipt of the Notification of Award, the successful Bidder shall submit Performance Security equal to 10 % of the Contract Price and in the form stipulated in the BDS, denominated in the type and proportions of currencies in the Notification of Award.
- 40.2. Failure of the successful Bidder to comply with the requirements of ITB. 40.1 and shall constitute sufficient grounds for cancellation of the award and forfeiture of the Bid Security.
- 40.3. Upon the successful Bidder's signing of the Contract and furnishing of the Performance Security pursuant to ITB 41.1, the Employer shall promptly notify the name of the winning Bidder to each unsuccessful Bidder and shall discharge the Bid Securities of the unsuccessful Bidders.

41. Signing of Contract

- 41.1. Upon accepting the Notification of Award (NoA), the successful Bidder shall submit the Performance Security and sign the Contract within seven (7) days as per form 3 Section VII.
- 41.2. Where the Contract is not signed by both parties in person:
- a) The Employer shall send to the successful Bidder a duly signed copy comprising of complete Contract documents and the NoA. These documents shall be signed by the successful Bidder or its duly authorized representative, together with the date of signature, for the Contract to be effective;



- b) The NoA shall indicate the deadline within which the successful Bidder shall sign these documents with the date of signature and return a copy to the Employer, in accordance with the mode of delivery including electronic mode (e.g., scanned copy with electronic signature, etc.) as may be specified by the Employer in the NoA;
- c) The Contract shall become effective from the date of signing these documents;
- d) Failure of the successful Bidder to accept the award/ sign the contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security.

42. Vendor Performance Management System (VPMS)

- 42.1. The performance of the Contractor shall be assessed as per the VPMS available on the Employer's website to assess the performance of the Contractor. In addition to this, any other Contractor performance rating system may apply, as applicable.

43. Complaint and Review

- 43.1. If the Bidder has or is likely to suffer, loss or injury due to a breach of a duty imposed on the Employer by the provisions of this bidding document, the Bidder shall submit the complaint in writing to the Employer within five (5) days from the date of Notification of Award.
- 43.2. The Head of Procuring Agency shall, within 5 days after the submission of the complaint, issue a written decision.



SECTION II – BID DATA SHEET

BID DATA SHEET

The Bid Data Sheet (BDS) contains information and provisions that are specific to a particular bidding process. The Employer must specify in the BDS only information that the Instructions to Bidders (ITB) request to be specified in the BDS. All information shall be provided, and no clause shall be left blank. To facilitate the preparation of the BDS, its clauses are numbered with the same numbers as the corresponding ITB clauses. This guide provides information to the Employer on how to enter all required information and includes a BDS format that summarizes all information to be provided.

Whenever there is a conflict, the provisions herein shall prevail over those in the ITB.

ITB	Particulars
4.4	The Bidder <i>is not</i> required to be represented by an agent in Bhutan.
5.1(h)	Insert names of the countries from which contracting of works or any payments to persons or entities in that country are prohibited. <i>Not applicable</i>
6.1 and 6.2	Joint Venture/Consortium (JV/C) Bids are permitted: <i>“No”</i>
9.1, 9.4 and 12.1	For Bid clarification purposes, the Employer’s address is: Attention: <i>Chief Divisional Manager</i> Address: <i>Electricity Services Division, DD, ESD, BPC, Trashigang</i> Phone number: +975 (4) 521109/ +975-17962688 Electronic mail: esdtgang@bpc.bt / sangaywangdi@bpc.bt Bid clarification requests will be received on or before: Time: <i>1700 Hours</i> Date: <i>May 17, 2024</i>
10.1	The Bidder shall make an appointment for the site visit and the contact person(s) for the visits shall be as below: Managers of respective ESD’s
11.1	A pre-bid meeting <i>“shall not”</i> take place.
15.1	Alternative Bids <i>“shall not be”</i> permitted.
16.1 (i)	The Bidder shall submit with its Bid the following additional documents: a) <i>Valid Trade License;</i> b) <i>Latest Tax Clearance Certificate;</i> c) <i>Valid CDB registration Certificate;</i>
16.1 (g)	Deviation to any of these clauses anywhere in the Bid shall not be permitted: i. GCC 1.4: Governing Laws



	<ul style="list-style-type: none"> ii. GCC 19: Settlement of Disputes iii. GCC 13: Contract Price iv. GCC 3.2: Performance Security v. GCC 15.4: Patent Indemnity vi. GCC 10.3: Defect Liability vii. GCC 15.5: Limitations of Liability viii. GCC 8.1: Time for Commencement and Completion
19.2	The prices quoted by the Bidder <i>“shall not”</i> be adjustable.
20.1	The Currencies of Bid shall be <i>“Bhutanese Ngultrum”</i>
21.1	The Bid validity period shall be 60 days from the last date of bid submission i.e., up to July 23, 2024 .
22.1	The Bidder shall furnish a bid security of Nu.36,895.00 which shall be valid up to August 23, 2024 , in favor of the Chief Divisional Manager, Electricity Services Division, BPC, Trashigang.
22.2	<p>The Bid Security shall be provided in any one of the following forms issued/enforceable by any Financial Institution in Bhutan:</p> <ul style="list-style-type: none"> i. An unconditional and irrevocable Bank Guarantee; or ii. A Banker’s Cheque/ Cash Warrant; or iii. A Demand Draft;
22.4	The Bid Security shall be valid till August 23, 2024
23.1	In addition to the original Bid, the number of copies is: One copy (Bid form and BOQ)
24.3	<p>For bid submission only, the Employer’s address is:</p> <p>Chief Divisional Manager Electricity Services Division Distribution Department Bhutan Power Corporation Limited Trashigang, Bhutan</p>





SECTION III – BIDDING FORMS

(Form No. 1 to Form No. 8)

Applicable forms from this section shall be submitted by the Bidder along with the Bid

FORM 1: BID SECURITY (BANK GUARANTEE)

Bank Guarantee No.

Date.....

To

[Employer's Name and Address]

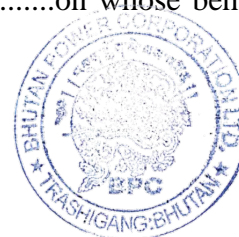
Dear Sir/ Madam,

In accordance with NIT No., M/s having its Registered/Head Office at (Here-in-after called the 'Bidder') wish to participate in the said Tender for[Name of Package]

As an unconditional and irrevocable bank guarantee against Bid Security for an amount of[insert currency and amount in words and figures*] valid up to.....[insert date@]is required to be submitted by the Bidder as a condition precedent to participating in the said Tender which amount is liable to be forfeited on the happening of any of the events mentioned in the Bidding Document.

We, the[Name & address of the Bank] having our Head Office at (#) guarantee and undertake to pay immediately on demand by the Employer or its authorized representative, the amount of[insert currency and amount in words and figures*] without any reservation, protest, demand, or recourse. Any such demand made by the Employer shall be conclusive and binding on us irrespective of any dispute or difference raised by the Bidder.

This Guarantee shall be irrevocable and shall remain valid up to(@) If any further extension of this guarantee is required, the same shall be extended to such required period on receiving instructions from M/s..... [Bidder's Name]on whose behalf this guarantee is issued.



All rights of Employer under this Guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities there under unless a demand or claim is lodged by Employer under this Guarantee against the Bank within thirty (30) days from the above-mentioned expiry date of validity or, from that of the extended date.

In witness where of the Bank, through its authorized officer, has set its hand and stamp on this.....day of.....20.....at.....

WITNESSES: SIGNATURE OF AUTHORIZED SIGNATORY OF THE BANK

1.	1.
.....
(Signature)	(Signature)
.....
(Name)	(Name)
.....
(Official Address)	(Designation)

Authorized vide

Power of Attorney No.....

Date.....

2.	2.
.....
(Signature)	(Signature)
.....
(Name)	(Name)
.....
(Official Address)	(Designation)

Authorized vide

Power of Attorney No.....



Date.....

Note: (*) *Shall be as specified in the BDS.*

(@) *The Bid security shall be valid till the date as specified in BDS.*

(#) *The complete mailing address of the Head Office and issuing branch of the Bank is to be given with fax no./telephone no. of the contact person*



FORM 2: INTEGRITY PACT STATEMENT

This agreement should be a part of the tender document, which shall be signed and submitted along with the tender document. The head of the employing agency/or his authorized representative should be the signing authority. For the Bidders, the Bidder himself or his authorized representative must sign the integrity pact (IP). If the winning Bidder had not signed during the submission of the bid; the tender shall be rejected/canceled.

INTEGRITY PACT

1: General

Whereas the **Chief Divisional Manager, Electricity Services Division, Distribution Department, Bhutan Power Corporation Limited, Trashigang**, here in after referred to as the Employer one part, and (Mr..... representing the (*name of person, the firm/construction Employer*) on the other part (hereafter referred to as the Bidder) here by execute this agreement as follows:

2. Objectives

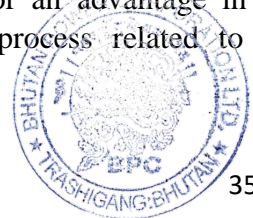
Now, therefore, the employer and the Bidder agree to enter into this pre-contract agreement, here in after referred to as an integrity pact, to avoid all forms of corruption by following a system that is fair, transparent, and free from any influence/ unprejudiced dealings before, during and after the currency of the contract to be entered into, with a view to:

- 2.1. Enable the Employer to obtain the desired contract at a reasonable and competitive price in conformity to the defined specifications of the works, goods, and services; and
- 2.2 Enable Bidders to abstain from bribing or any corrupt practice to secure the contract by assuring them that their competitors shall also refrain from bribing and other corrupt practices and the Employer shall commit to prevent corruption, in any form by their officials by following transparent procedures.

3. Commitments of the Employer

The Employer commits itself to the following:

- 3.1. The Employer hereby under takes that no official of the Employer, connected directly or indirectly with the Contract, shall demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward favour or any material or immaterial benefit or any other advantage from the Bidder, either for themselves or for any person, organization or third party related to the Contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the Contract.

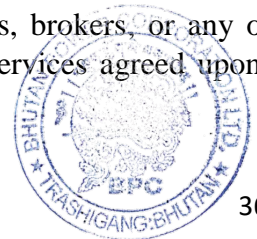


- 3.2. The Employer further confirms that its officials have not favored any prospective Bidder in any form that could afford an undue advantage to that particular Bidder during the tendering stage, and shall further treat all Bidders alike.
- 3.3 All the officials of the Employer shall report to the Chief Executive Officer, Employer, any attempted/completed violation of clauses 3.1 and 3.2.
- 3.4 Following report on violation of clauses 3.1 and 3.2 by the official (s), through any source, necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the Employer and such a person shall be debarred from further dealings related to the Contract process. In such a case while an inquiry is being conducted by the Employer the proceedings under the Contract would not be stalled.

4. Commitments of Bidders

The Bidder commits himself to take all measures necessary to prevent corrupt practices, unfair means, and illegal activities during any stage of his bid or any pre-contract or post-contract stage to secure the Contract or in furtherance to secure it and in particular commits himself to the following:

- 4.1 The Bidder shall not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, commission, fees, brokerage, any materials or immaterial benefit to any official of the Employer, connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting, and implementation of the Contract.
- 4.2 The Bidder further undertakes that he has not given, offered, or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, commission, fee, brokerage, or any material or immaterial benefit to any official of the Employer or otherwise in procuring the Contract or forbearing to do or have done any act in relation to the obtaining or execution of the Contract or any other contract with the Employer for showing or forbearing to show favour or disfavor to any person in relation to the Contract or any other contract with the Employer.
- 4.3 The Bidder shall not collude with other parties interested in the contract to preclude the competitive bid price, impair the transparency, fairness, and progress of the bidding process, bid evaluation, contracting, and implementation of the contract.
- 4.4 The Bidder, either while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to, or intends to make to officials of the Employer or their family members, agents, brokers, or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.



- 4.5 The Bidder shall not enter into any monetary dealings or transaction, directly, with any tender committee member, and if he does so, the Employer shall be entitled forthwith to rescind the Contract and all other contracts with the Bidder.

5. Sanctions for Violation

The breach of any aforesaid provisions or providing false information by employers, including manipulation of information by evaluators, shall face administrative charges and penal actions as per the existing relevant rules and laws.

The breach of the Pact or providing false information by the Bidder, or any one employed by him, or acting on his behalf (whether with or without the knowledge of the Bidder), or the commission of any offence by the Bidder, or any one, employed by him, or acting on his behalf, shall be dealt with as per the provisions of the Penal Code of Bhutan, 2004, and the Anti – Corruption Act, 2006.

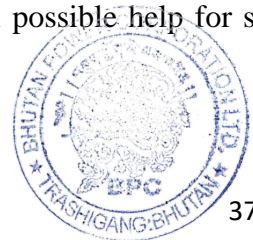
In the event of a breach, the Employer shall also take all or any one of the following actions, wherever required:

- 5.1 Immediately call off the pre-contract negotiations without giving any compensation to the Bidder. However, the proceedings with the other Bidder(s) would continue.
- 5.2 Immediately cancel the contract, if already awarded/signed, without giving any compensation to the Bidder.
- 5.3 Forfeit the Earnest Money/security deposited with the Employer.
- 5.4 Recover all sums already paid to the Bidder.
- 5.5 Encash the advance bank guarantee and performance bond /warranty bond, if furnished by the Bidder, in order to recover the payments, already made by the Employer, along with interest.
- 5.6 Cancel all or any other Contracts with the Bidder.
- 5.7 Debar the Bidder from entering into any bid from the Employer as per the Debarment Rule.

6. Examination of Books of Accounts

- 6.1 In case of any allegation of violation of any provisions of this integrity pact or payment of a commission, the Employer/authorized persons or relevant agencies shall be entitled to examine the Books of Accounts of the Bidder and the Bidder shall provide necessary information of the relevant financial documents and shall extend all possible help for such examination.

7. Monitoring and Arbitration



7.1 The Employer shall be responsible for monitoring and arbitration of IP as per the procurement rules.

8 Legal Actions

8.1 The actions stipulated in this integrity pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceeding.

9. Validity

9.1 The validity of this integrity pact shall cover the tender process and extend until the completion of the contract to the satisfaction of both the employer and the Bidder.

9.2 Should one or any provision of this pact turn out to be invalid, the remainder of this pact remains valid. In this case, the parties shall strive to agree with their original intentions.

We, hereby, declare that we have read and understood the clauses of this agreement and shall abide by it. Further, the information provided in this agreement is true and correct to the best of our knowledge and belief.

The parties here by sign this Integrity pact at Trashigang on



(Sangay Wangdi)
Chief Divisional Manager, ESD

(.....)
CID #

Witness

Name: Dekar Wangchuk
CID#: 11106003086

Name:
CID#:



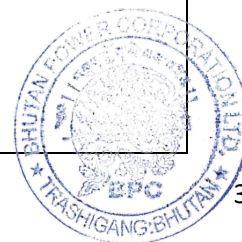
FORM 3: BIDDER’S INFORMATION FORM

[The Bidder shall fill in this Form in accordance with the instructions indicated below. No alterations to its format shall be permitted and no substitutions shall be accepted.] Not Applicable

Date:[insert date of Bid submission]

NIT No.:

1.	Bidder’s Legal Name:
2.	In the case of a Joint Venture (JV) legal name of each member of the Joint Venture:
3.	Bidders or each member of JV’s Country of Registration:
4.	Bidders or Each member of JV’s Year of Registration:
5.	Bidders or Each member of JV’s Legal Address in the Country of Registration:
6.	Bidder’s or Lead member of JV’s Local Address in Bhutan (if any):
7.	Bidders or Each member of JV’s Website Address:
8.	Bidders or Each member of JV’s Business Activities:
9.	Bidder’s or Lead member of JV’s Authorized Representative Name: Designation: Address: Telephone: E-mail Address:



10.	<p>Bidder's or Lead member of JV's Authorized Representative in Bhutan (if any)</p> <p>Name of the Employer or firm:</p> <p>Name of the contact person:</p> <p>Designation:</p> <p>Address:</p> <p>Telephone:</p> <p>E-mail Address:</p> <p>Services to be provided by the local representative:</p>
11.	<p>Status of the Bidder (check the box as applicable):</p> <ul style="list-style-type: none"> • Bidding Company • Lead Member of the Joint Venture • Agent of the Foreign Bidder
12.	<p>Attached are copies of the following original documents: <i>[check the box(es) of the attached original documents]</i></p> <ul style="list-style-type: none"> • Tax Clearance Certificate of Bidder named in 1 or 2 above (applicable for Bhutanese Bidders) • Trade License of Bidder named in 1 or 2 above (applicable for Bhutanese Bidders) • Certificate of Incorporation or Registration of Bidder named in 1 or 2 above • Any other certificate to support the legal entity of the Bidder named in 1 or 2 above

Date:

Signature.....

Place:

Name.....

Designation.....

Seal.....



FORM 4: POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS THAT WE, *[insert name of the Bidder]* an Employer incorporated under the *[insert relevant statute of the country of incorporation]* and having its registered office at *[insert address]* (Hereinafter referred to as the “Bidder”) having been authorized by the Board of Directors of the Employer, inter alia, to execute contracts in the name of and for and on behalf of the Employer. I *[insert name of the person giving the power of attorney]* presently holding the position of *[insert designation of the person giving the power of attorney]* in the Employer do hereby constitute, appoint and authorize Mr. *[insert name, designation and residential address of the person to whom the power of attorney is being given]* as our true and lawful attorney to do in our name and on our behalf all such acts, deeds, things necessary and incidental to submission of our Bid against NIT No., floated by Employer. I hereby further authorize the above attorney to sign and submission the Bid and all other documents, and information related to the Bid including undertakings, letters, certificates, declarations, clarifications, acceptances, guarantees, any amendments to the Bid, and such documents related to the Bid, and providing responses and representing us in all the matters before Employer in connection with the Bid for the said NIT till the completion of the bidding process.

I accordingly hereby nominate, constitute, and appoint above named severally, as my lawful attorney to do all or any of the acts specifically mentioned immediately herein above.

We do hereby agree and undertake to ratify and confirm whatever the said Attorney shall lawfully do or cause to be done under and by virtue of this power of Attorney and the Acts of Attorney to all intents and purposes are done as if I had done the same on behalf of the Employer if these presents had not been made.

IN WITNESS whereof I, have executed these presents this the day of at

EXECUTANT

Signature.....

Name:

Designation.....

ACCEPTED:



Signature of Attorney.....

Name:

Designation.....

Signature of the Attorney Attested

.....

EXECUTANT

Name.....

Designation.....

Office Seal.....

Note: The Power of Attorney should be notarized as per applicable legal provisions in the country of the Bidder

FORM 5: DEVIATION SCHEDULE (IF APPLICABLE)

NIT No: _____

To:

[Employer's relevant official, name and address]

Sir/Madam,

The following are the deviations and variations from and exceptions to the terms, conditions, and specifications of the Bidding Documents for procurement of.....*[insert a brief description of works]* These deviations and variations are exhaustive. We are furnishing below the cost of withdrawal for the deviations and variations stated in this Form. We shall withdraw the deviations proposed by us in this Form at the cost of withdrawal indicated herein, failing which our Bid may be rejected and bid security forfeited.

We confirm that except for the deviations and variations stated in this Form to our Bid, the entire work shall be performed as per specifications and conditions of the Bidding Documents without any extra cost to Employer, irrespective of any mention to the contrary anywhere else in the Bid, failing which our Bid may be rejected and Bid security forfeited.

Further, we agree that additional conditions, deviation, if any, found in the Bidding Documents other than those stated in this Form, save those pertaining to any rebates offered, shall not be given effect.

Section / Clause No	Page No.	Statement of Deviations	Cost of withdrawal
---------------------	----------	-------------------------	--------------------

Date:

(Signature).....

Place:

(Name).....

(Designation).....

(Seal).....

Note: Continuation sheets of similar size and format may be used and annexed to this Form if required.



FORM 6: BID SUBMISSION FORM

Date:

Invitation no.....and Title of
Contract.....
..

To:

.....,
.....,
.....,
.....,

Employer
[Address]

We, the undersigned, declare that:

- a) Having examined all the Bidding Documents (with reference ITB 10), including addenda [insert list], we offer to execute thein accordance with the Conditions of Contract accompanying this Bid for the Contract Price of
BTN.....*In figures*),
Ngultrums.....
.....*(In words)*.
- b) This Bid and your written acceptance of it shall constitute a binding Contract between us. We understand that you are not bound to accept the lowest or any Bid you receive.
- c) We hereby confirm that this Bid complies with the Bid validity and Bid Security required by the Bidding Documents and specified in the Bidding Data Sheet.
- d) We, including any subcontractors for any part of the Contract, have nationalities from eligible countries in accordance with ITB Clause 7;



- e) We have no conflict of interest in accordance with ITB sub-clause 5.2;
- f) Our firm, its affiliates, or subsidiaries—including any subcontractors for any part of the Contract—have not been declared ineligible under the laws or official regulations of Bhutan, in accordance with ITB Clause 6 and other relevant clauses.
- g) Commissions or gratuities, if any, paid or to be paid by us to agents relating to this Bid, and to contract execution if we are awarded the contract, are listed below:

Name & address of agent	Amount & Currency	Purpose of commission or gratuity
Bhutan Power Corporation Limited		

** If none, please state none*

- h) Our duly executed Integrity Pact Statement is attached herewith.
- j) We accept the vendor performance management system.

AUTHORIZED SIGNATURE: _____ (AFFIX LEGAL STAMP)

Name and title of signatory:

Name of Bidder: _____

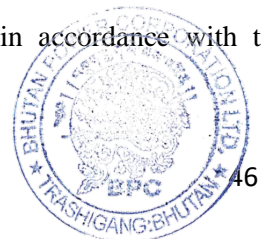
Address:



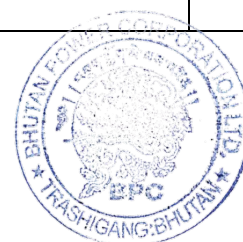
FORM 7: PRICE BILL OF QUANTITIES (ATTACHED)

Preamble

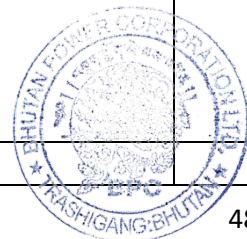
1. The bill of Quantities shall be read in conjunction with the Instructions to Bidders, Conditions of the Contract, Technical Specifications, and Drawings.
2. The quantities given in the bill of Quantities are estimated and provisional only and are given to provide a common basis for bidding. The basis of payment will be on the actual quantities of work carried out, as measured by the contractor and the employer's representatives jointly and valued at the rates and prices rendered in the priced bill of Quantities, where applicable, and otherwise at such rates and prices as the engineer may fix within the terms of the contract. No Price variation on account of quantity variation will be applicable as per the conditions of this contract.
3. The rates and prices tendered in the priced bill of quantities shall, except in so far as it is otherwise provided under the contract, include all constructional plant, labour, supervision, materials, erection, maintenance, insurance, profit, taxes, and duties, together with all general risks, liabilities and obligations set out or implied in the contract.
4. A rate or price shall be entered against each item in the bill of quantities, whether quantities are stated or not. The cost of the item against which the contractor has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the bill of quantities.
5. The whole cost of complying with the provisions of the contract shall be included in the items provided in the priced bill of quantities. Where no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of work.
6. General directions and descriptions of work and materials are not necessarily repeated or summarized in the bill of quantities are not necessarily repeated or summarized in the bill of quantities. References to the relevant sections of the contract documentation shall be made before entering rates or prices against each item in the bill of quantities.
7. Provisional sums designated in the bill of quantities shall be expanded in whole or part at the employer's direction and discretion.
8. The measurement method of completed work for payment shall be in accordance with the SI measurement system.



Labour Contract of CWIP Works under ESD Trashigang						
Sl. No.	Description	Unit	Qty.	Rate (Nu.)	Amount (Nu.)	Rate (in words)
A	Realignment of 33 kV incomer lines from Phugayee to Wakhar road junction along the Trashigang - Samdrup Jongkhar National Highway.					
1	Detailed route survey, clearing of jungle/bushes, felling of trees including cutting of trunks, branches & removing the trees (especially blocking of footpath & roads), transportation of materials both head loading and vehicular from stores to sites, digging of holes, erection of poles, laying and stringing of conductors, fittings and accessories, erection of ABS/LBS unit and its supports, supply of miscellaneous items such as nut & bolt, lugs, etc., modification of fittings like drilling, welding, etc., testing, commissioning and any other associated works. Dismantling of MV poles and fixtures, and rolling of conductors and transportation up to Wamrong store. Conversion of ACSR Rabbit to ACSR Dog conductors.					
1.1	33 kV lines (ACSR Dog Conductor 3 phase, 3 wire) with GI Steel Tubular Poles 10 m,	km	2.00			
1.2	Dismantling of old MV Lines	km	1.68			
1.3	33 kV ABS/LBS Unit (1set =3 Nos.)	Set	2.00			
1.4	ACSR Rabbit to ACSR Dog Conversion (33 kV)	km	0.5			
B	Interconnection of 11kV Bidhung Feeder (Yabrang) and Radhi Feeder (Janjanma).					



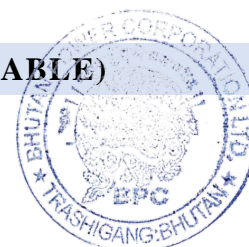
1	Detailed route survey, clearing of jungle/bushes, felling of trees including cutting of trunks, branches & removing the trees (especially blocking of footpath & roads), transportation of materials both head loading and vehicular from stores to sites, digging of holes, erection of poles, laying and stringing of conductors, fittings and accessories, erection of ABS/LBS unit and its supports, supply of miscellaneous items such as nut & bolt, lugs, etc., modification of fittings like drilling, welding, etc., testing, commissioning and any other associated works.					
1.1	11 kV lines (ACSR Dog Conductor 3 phase, 3 wire) with GI Steel Tubular Poles 10 m	km	2.00			
1.2	11 kV ABS/LBS Unit (1set =3 Nos.)	Set	2.00			
C	Upgradation of 11kV lines from Squirrel to Rabbit ACSR conductor from T-off point to 100 kVA Gomchu Substation.					
1	Detailed route survey, clearing of jungle/bushes, felling of trees including cutting of trunks, branches & removing the trees (especially blocking of footpath & roads), transportation of materials both head loading and vehicular from stores to sites, digging of holes, erection of poles, laying and stringing of conductors, fittings and accessories, supply of miscellaneous items such as nut & bolt, lugs, etc., modification of fittings like drilling, welding, etc., testing, commissioning and any other associated works. Dismantling of squirrel conductors, and transportation up to Wamrong Store.					
1.1	11 kV lines (ACSR Rabbit conductor	km	1			



DHI Group – Standard Bidding Document for Works

	3 phase, 3 wire) with GI Steel Tubular Poles 10 m					
		Total Amount (Nu.)				
In Word(_____)only						

FORM 8: PRICE ADJUSTMENT DATA (NOT APPLICABLE)



49

NIT No:

To,

[Name, Designation, and address of Employer]

Dear Sir,

We hereby furnish the relevant details pertaining to the price adjustment provisions in your specifications and documents.

Sl No.	Variables	Name of the published index and its origin	Value of indices as of 30 days prior to the date set for Opening of bids.
	Material		
	Labour		

Date:

Signature.....

Place:

Name.....

Designation.....

Seal.....

Note:

- Bidders shall note that it is mandatory to furnish the values of various indices and name, source & origin of the published indices, wherever called for in the bidding document. Bidders are also required to mention whether the indices are monthly average, weekly average, or as applicable.*

** Continuation sheets of like size & format shall be used, if required, in case the number of currencies is more than one.*

*** Continuation sheets of like size and format may be used, if countries of origin of expatriate labour are more than one.*

SECTION IV – GENERAL CONDITION OF CONTRACT

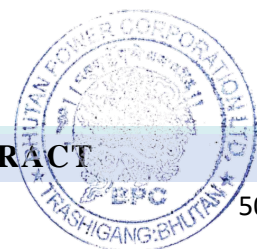


TABLE OF CONTENTS

1.	General Provisions	53
1.1.	Definitions	54
1.2.	Interpretation	56
1.3.	Notices	57
1.4.	Governing Law and Language	58
1.5.	Assignment	58
1.6.	Fraud and Corruption	59
1.7.	Joint Venture	59
2.	The Employer	60
2.1.	Access to Site	60
2.2.	Employer Representative	60
2.3.	Employer's Responsibilities	61
3.	The Contractor	62
3.1.	Responsibility of the Contractor	62
3.2.	Performance Security	63
3.3.	Contractor's Representative and Construction Manager	63
3.4.	Opportunities for other Contractors	65
3.5.	Emergency Work	65
3.6.	Progress Review Meetings	66
3.7.	Protection of the Environment	66
3.8.	Site Regulations and Safety	66
3.9.	Site Clearance	66
3.10.	Watching and Lighting	67
3.11.	Explosives	67
3.12.	Temporary Utilities	67
3.13.	Working hours	67
3.14.	Program of Performance	68
3.15.	Progress of Performance	68
4.	Subcontracting	68
5.	Contractor's Staff/Labour and Equipment	69
5.1.	Key Personnel	69
		51

5.2.	Labour	69
5.3.	Contractor's Equipment	70
6.	Plant, Material and Workmanship	71
6.1.	Methodology of Construction & Equipment mobilization	71
6.2.	Test and Inspection	71
7.	Work Execution	73
7.1.	Benchmark	73
7.2.	Contractor's Supervision	73
7.3.	Quality Assurance Program.....	73
7.4.	Progress Report.....	73
7.5.	Materials obtained from excavation.....	74
8.	Commencement, Delays and Suspension.....	74
8.1.	Time for commencement and completion	74
8.2.	Manner of Execution.....	74
8.3.	Extension of Time for Completion	75
8.4.	Liquidated Damages	76
9.	Taking Over	76
9.1.	Test on Completion.....	76
9.2.	Taking Over of Works	77
9.3.	Operating and Maintenance Manuals	78
10.	Defects.....	78
10.1.	Correction of Defects	78
10.2.	Uncorrected Defects.....	78
10.3.	Defect Liability	79
11.	Measurement and Valuation	80
12.	Variations and Adjustments	81
12.1.	Contract Price Adjustment	81
12.2.	Change in Works.....	83
12.3.	Variations in Contract	84
12.4.	Adjustment of the Contract Price	84
12.5.	Day Work.....	86
12.6.	Record of costs.....	86
12.7.	Change in Laws and Regulations	87



13.	Contract Price and Payment	87
13.1.	Contract Price	87
13.2.	Advance Payment.....	87
13.3.	Terms of Payment.....	89
13.4.	Taxes and Duties	89
13.5.	Retention Money.....	90
14.	Termination.....	90
14.1.	Termination for Employer’s Convenience	90
14.2.	Termination for Contractor’s default	90
14.3.	Termination by Contractor.....	92
14.4.	Payment upon Termination	93
14.5.	Suspension.....	94
15.	Care of the Works and Indemnities	95
15.1.	Protection of Works.....	95
15.2.	Copyright.....	95
15.3.	Confidential Information.....	95
15.4.	Patent Indemnity	96
15.5.	Limitations of Liability.....	97
15.6.	Indemnification Employer	98
16.	Exceptional Event (Force Majeure)	99
17.	Insurance.....	100
18.	Claims	101
18.1.	Contractor’s Claims.....	101
18.2.	Claims towards idling of resources	103
18.3.	Early Warning.....	103
19.	Disputes and Arbitrations.....	103
19.1.	Amicable Settlement	103
19.2.	Dispute Resolution	104

1. General Provisions



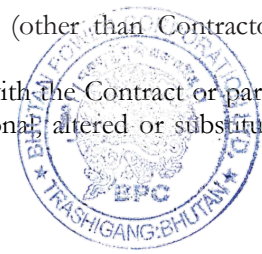
1.1. Definitions

1.1.1. The following words and expressions shall have the meaning hereby assigned to them except where the context otherwise requires.

- (i) Affiliate means business concerns, organizations, or individuals that control each other or that are controlled by a common third party. Control may include shared management or ownership; common use of facilities, equipment, and resources; or family interests.
- (ii) Employer means the Employer including its legal successors and permitted assigns. The terms “Employer” and “Employer” are synonymous.
- (iii) Bid means an offer to execute Works in accordance with the terms and conditions set out in the bidding documents inviting such offers. The term “tender” is synonymous with the term “bid”.
- (iv) A Bid Data Sheet (BDS) is a proforma sheet, that contains data and information specific to a particular work.
- (v) Bidder means an eligible individual, firm, legal entity, or joint venture that participates in a competitive bidding process governed by the bidding documents.
- (vi) Bidding Document means the set of documents sold or issued by the Employer to potential Bidders in which the specifications, terms, and conditions of the proposed procurement are prescribed. The terms “Bidding Documents”, “Tender Documents” and “Bid Documents” are synonymous.
- (vii) A Bill of Quantities (BoQ) is a summary of the quantities and unit prices of the items of work proposed and agreed upon under the contract.
- (viii) Contract means formal agreement(s) in writing entered into simultaneously between Employer and the Contractor on mutually agreed terms and conditions including the Contract Documents and amendments thereto under Notification of Award issued by Employer and accepted by the Contractor and which comply with all the relevant provisions of the Governing Law of the Contract as per GCC 1.4.
- (ix) Contract Document means the documents referred to in the Contract Agreement.
- (x) Contract Price means the price payable to the Contractor as specified in the Contract Agreement, subject to such additions and adjustments thereto or deductions therefrom as may be made under the provisions of the Contract till the completion of the contract, the price so adjusted shall be termed as executed/final Contract Price.
- (xi) Contractor means an individual or legal entity whose Bid to perform the Contract has been accepted by the Employer and is named as such in the Contract Agreement, and includes the legal successors or permitted assigns of the Contractor.
- (xii) Contractor’s Representative means any person nominated by the Contractor and approved by the Employer in the manner provided in GCC 3.3 hereof to perform the duties assigned by the Contractor.
- (xiii) Contractor’s Equipment means all plant, facilities, equipment, machinery, tools, apparatus, appliances, or things of every kind required for erection, completion, and maintenance of works that are to be provided by the Contractor but does not include plant, equipment, materials or other things intended to form or forming part of the works.
- (xiv) Day means the calendar day of the Gregorian calendar.
- (xv) Day works are varied work inputs subject to payment on a time basis for the Contractor’s employees and Equipment, in addition to payments for associated Materials and Plant.



- (xvi) Defect Liability Period means the period of validity of the warranties given by the Contractor commencing at completion of the Works or a part thereof if separate completion of the Works for such part has been provided in the Contract, during which the Contractor is responsible for defects with respect to the Works (or the relevant part thereof) as provided in GCC 10.3 hereof.
- (xvii) The Defects Liability Certificate is the certificate issued by the Employer upon correction of defects by the Contractor.
- (xviii) Drawings include calculations and other information provided or approved by the Employer for the execution of the Contract.
- (xix) Effective Date means the date of Notification of Award/ Work Order/Contract Signing and from which the time for completion shall be determined.
- (xx) Foreign Bidder shall mean any Bidder having nationality of any country other than Bhutan.
- (xxi) Joint Venture or “JV” means a joint venture, association, or consortium of not more than four (4) legal entities that pool their resources and skills to undertake a large or complex Contract in the role of a Contractor, with all legal entities (members in the JV) being legally liable, jointly and severally, through a joint venture agreement between the members of the JV for the execution of the Contract in the event of a member’s withdrawal.
- (xxii) Notification of Award (NoA) means the letter or order issued by the Employer conveying the acceptance of the Bid of the successful Bidder subject to such terms and conditions as may have been stated therein.
- (xxiii) Local Transportation shall include loading, unloading, and handling of plant, equipment, and materials at the port of entry in India/airport in Bhutan; storage at the port/airport, if required, and subsequent transportation from the port of entry/airport up to the Site.
- (xxiv) Month means calendar month of the Gregorian calendar.
- (xxv) Materials are all supplies, including consumables, used by the Contractor for incorporation in the Works.
- (xxvi) Party means the Employer or the Contractor, as the context requires, and “Parties” means both of them.
- (xxvii) Project Manager means the person appointed by Employer in the manner provided in GCC hereof and named as such in the SCC to perform the duties delegated by Employer.
- (xxviii) The plant is any integral part of the Works that shall have a mechanical, electrical, chemical, or biological function.
- (xxix) Site is the area defined as such in the SCC.
- (xxx) Subcontractor means any person named in the Contract as a subcontractor, or any person appointed by the Contractor as a subcontractor or designer, for a part of the works; and the legal successors in title to each of these persons.
- (xxxi) Time for Completion means the time within which completion of the Works as a whole (or of a part of the Works where a separate Time for Completion of such part has been prescribed) is to be attained in accordance with the stipulations in the SCC and the relevant provisions of the Contract.
- (xxxii) Technical Specifications means specifications of the Works incorporated in the bidding documents and forming part of the contract and includes any modification or amendment thereto or any addition thereto or any deduction therefrom, as may be made with the mutual agreement of the Employer and Contractor.
- (xxxiii) Temporary Works means all temporary works of every kind (other than Contractor’s Equipment) required on-site for the execution of the Works.
- (xxxiv) Works shall mean the total work to be executed in accordance with the Contract or part(s) thereof, as the case may be, and shall include all extra or additional, altered or substituted



works or temporary/enabling works and urgent works as required for the performance of the Contract.

(xxxv) A Variation means any change to the Works, which is instructed as a variation under Clause.

1.2. Interpretation

1.2.1. In the Contract, except where the context requires otherwise:

- a. Words indicating one gender shall include all genders;
- b. Words indicating the singular also include the plural and words indicating the plural also include the singular;
- c. Provisions including the word “agree,” “agreed,” or “agreement” require the agreement to be recorded in writing;
- d. “Written” or “in writing” means hand-written, type-written, printed, or electronically made, resulting in a permanent record;
- e. “may” means that the party/person referred to has the choice whether to act or not in the matter referred to; and
- f. “shall” means that the party/person referred to has an obligation under the Contract to perform the duty referred to.

1.2.2. "Month" and "Year" and all dates shall be reckoned according to the Gregorian calendar.

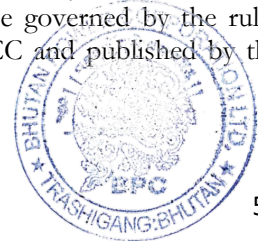
1.2.3. A “law” shall be construed as a reference to such law including its amendments or reenactments from time to time.

1.2.4. A “person” shall be construed as a reference to any person, firm, Employer, corporation, society, trust, government, or agency of a government or any association or partnership (whether or not having separate legal personality) of two or more of the above and a person shall be construed as including a reference to its successors, permitted transferees and permitted assigns in accordance with their respective interests.

1.2.5. The words “hereof” or “herein” if and when used in the Contract Documents shall mean a reference to the Contract Documents of this Contract.

1.2.6. Incoterms

- a) Unless inconsistent with any provision of the Contract, the meaning of any trade term, when used, and the rights and obligations of Parties thereunder shall be governed by the rules prescribed in the current edition of Incoterms specified in the SCC and published by the International Chamber of Commerce in Paris, France.



1.2.7. Amendment

- a) No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract, and is signed by duly authorized representatives of the Employer and the Contractor.

1.2.8. Non-waiver

- a) Subject to 1.2.8(b) below, no relaxation, forbearance, delay or indulgence by either party in enforcing any of the terms and conditions of the Contract or the granting of time by either party to the other shall prejudice, affect, or restrict the rights of that Party under the Contract, nor shall any waiver by either Party of any breach of Contract operate as waiver of any subsequent or continuing breach of Contract;
- b) Any waiver of a party's rights, powers, or remedies under the Contract must be in writing, dated, and signed by an authorized representative of the party granting such waiver, and must specify the right and the extent to which it is being waived.

1.2.9. Severability

- a) If any provision or condition of the Contract is prohibited or rendered invalid or unenforceable, such prohibition, invalidity, or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of the Contract.

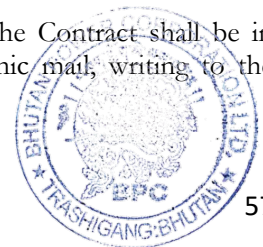
1.2.10. Entire Agreement

- a) The Contract constitutes the entire agreement between Employer and the Contractor, with respect to the subject matter of the Contract, and supersedes all communications, negotiations, and agreements (whether written or oral) of the Parties with respect thereto made prior to the date of Contract.

1.3. Notices

- 1.3.1. Notices shall be deemed to include any approvals, consents, instructions, orders, determinations, and certificates to be given under the Contract.

- 1.3.2. Unless otherwise stated in the Contract, all notices to be given under the Contract shall be in writing and shall be sent by personal delivery, courier, post, or electronic mail, writing to the address specified in the SCC.



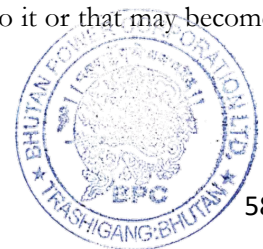
- 1.3.3. Any notice sent by post or courier shall be deemed (in the absence of evidence of earlier receipt) to have been delivered ten (10) days after dispatch. In proving the fact of dispatch, it shall be sufficient to show that the envelope containing such notice was properly addressed, stamped, and conveyed to the postal authorities or courier service for transmission by airmail or special courier.
- 1.3.4. Any notice delivered personally or by electronic mail shall be deemed to have been delivered on the date of its dispatch. Either Party may change its address at which notices are to be received and/or sent by giving ten (10) days' notices to the other Party in writing.

1.4. Governing Law and Language

- 1.4.1. The Contract shall be governed by and interpreted in accordance with the laws of the Kingdom of Bhutan.
- 1.4.2. The Contractor shall, in all matters arising in the performance of the Contract, comply in all respects, give all notices, and pay all fees required by the provisions of any statute, ordinance, or other law or any regulation or by-law of any duly constituted authority of the Kingdom of Bhutan.
- 1.4.3. The Contractor shall indemnify and hold Employer harmless from and against any liabilities, damages, claims, fines, penalties, and expenses of whatever nature arising or resulting from the violation of such laws by the Contractor or its personnel including its Sub-Contractors and their employees.
- 1.4.4. The Contract, as well as all correspondence and documents relating to the Contract exchanged by the Contractor and Employer, shall be written in English. Supporting documents and printed literature that are part of the Contract may be in another language provided they are accompanied by an accurate translation of the relevant passages in English, in which case, for purposes of interpretation of the Contract, the translation shall govern.
- 1.4.5. The Contractor shall bear all costs of translation to the governing language and all risks of the accuracy of such translation, for documents provided by the Contractor.

1.5. Assignment

- 1.5.1. The Contractor shall not, without the express prior written consent of Employer, assign to any third party the Contract or any part thereof, or any right, benefit, obligation or interest therein or thereunder, except that the Contractor shall be entitled to:
- 1.5.2. Assign either absolutely or by way of charge any monies due and payable to it or that may become due and payable to it under the Contract in favour of its bankers;



- 1.5.3. Assign to the insurers (in cases where the insurers have discharged the Contractor's loss or liability) the Contractor's right to obtain relief from any other liable party.

1.6. Fraud and Corruption

- 1.6.1. If Employer determines that the Contractor and/or any of its personnel, or its agents, or its subcontractors, and/or their employees have engaged in corrupt, fraudulent, collusive coercive, or obstructive practices, in competing for or in executing the Contract, then Employer may, after giving fourteen (14) days' notice to the Contractor, terminate the Contract and expel him from the site, and the provisions of GCC 14 shall apply as if such expulsion had been made under 14.2.1.

- 1.6.2. For the purposes of this sub-clause,

- a) "Corrupt practice" is the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;
- b) "Fraudulent practice" is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;
- c) "Collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;
- d) "Coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;
- e) "Obstructive practice" is
 - a. Deliberately destroying, falsifying, altering, or concealing of evidence material during an investigation or making false statements to investigators to materially impede any investigation into allegations of a corrupt, fraudulent, coercive, or collusive practice; and/or threatening, harassing, or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or
 - b. Acts intended materially to impede the exercise of the inspection rights of Employer or any organization or person appointed by Employer.

1.7. Joint Venture

- 1.7.1. If the Contractor is a joint venture, all such parties shall be jointly and severally bound to the Employer for the fulfillment of the obligations under the Contract and shall designate one of such

firms/parties to act as a leader with authority to bind the joint venture. The composition or the constitution of the joint venture shall not be altered without the prior consent of the Employer.

2. The Employer

2.1. Access to Site

- 2.1.1. Employer shall give access to and possession of all parts of the Site including special and/or temporary rights-of-way to the Contractor, free from all encumbrances. Employer reserves the right to hand over the Site in parts progressively to the Contractor. The Contractor shall be required to take possession of the Site without any undue delay and commence the Works on the released fronts in parts without any reservation whatsoever.
- 2.1.2. The Contractor shall allow the Project Manager and any person authorized by the Employer access to the Site and to any place where work in connection with the Contract is being carried out or is intended to be carried out.

2.2. Employer Representative

2.2.1. Project Manager

- a) If the Project Manager is not named in the Contract, then within fourteen (14) days of the Effective Date, the Employer shall appoint and notify the Contractor in writing of the name of the Project Manager. Employer may from time to time appoint some other person as the Project Manager in place of the person previously so appointed and shall give a notice of the name of such other person to the Contractor without delay. Employer shall take reasonable care to see that no such appointment is made at such a time or in such a manner as to impede the progress of Works. The Project Manager shall represent and act for Employer at all times during the currency of the Contract and carry out duties and responsibilities specified in the Contract. All notices, instructions, orders, certificates, approvals, and all other communications under the Contract shall be given by the Project Manager, except as herein otherwise provided.
- b) The Project Manager's representative shall be appointed by and be responsible to the Project Manager and shall carry out such duties and exercise such authority as may be delegated to him by the Project Manager under c) The Project Manager's representative shall have no authority to relieve the Contractor of any of his duties or obligations under the Contract except as expressly provided hereunder or elsewhere in the Contract, nor to order any work involving delay or any extra payment by Employer, nor to make any variation in the Works.
- c) The Project Manager may, from time to time delegate to the Project Manager's representative any of the powers and authorities vested in the Project Manager and he may at any time revoke such delegation. Any communication issued by the Project Manager's

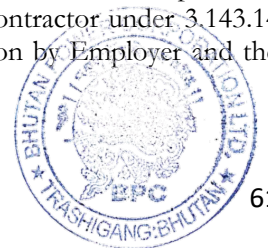


representative to the Contractor in accordance with such delegation shall have the same effect as though it had been issued by the Project Manager, provided that:

- d) Any failure on the part of the Project Manager's representative to disapprove any work or materials shall not prejudice the authority of the Project Manager thereafter to disapprove such work or materials and to give instructions for the removal or for the rectification thereof;
- e) If the Contractor questions any communication of the Project Manager's representative, he may refer the matter to the Project Manager who shall confirm, reverse, or vary the contents of such communication.
- f) The Project Manager or his representative may appoint any number of persons to assist the Project Manager's representative in carrying out his duties. Such assistants shall have no authority to issue any instructions to the Contractor save in so far as such instructions may be necessary to enable them to carry out their duties and to secure their acceptance of materials, plant, equipment, and machinery or workmanship as being in accordance with the Contract, and any instructions given by any of them for those purposes shall be deemed to have been given by the Project Manager's representative.

2.3. Employer's Responsibilities

- 2.3.1. Employer shall ensure the accuracy of all information and/or data to be supplied by Employer, except when otherwise expressly stated in the Contract.
- 2.3.2. Employer shall be responsible for acquiring and providing legal and physical possession of the site and access thereto, and for providing possession of and access to all other areas reasonably required for the proper execution of the Contract, including all requisite rights of way.
- 2.3.3. If requested by the Contractor, the Employer shall try its best to assist the Contractor in obtaining in a timely and expeditious manner all permits, approvals, and/or licenses necessary for the execution of the Contract from all government authorities or public service undertakings that such authorities or undertakings require the Contractor or subcontractors or the personnel of the Contractor or subcontractors, as the case may be.
- 2.3.4. If so specified in the SCC, the Employer shall provide qualified personnel; shall supply and make available all raw materials, utilities, lubricants, chemicals, catalysts, other materials and facilities and shall perform work and services of whatsoever nature to enable the Contractor to complete the Works at or before the time specified in the program furnished by the Contractor under 3.143.14 hereof and in the manner thereupon specified or as otherwise agreed upon by Employer and the Contractor.



3. The Contractor

3.1. Responsibility of the Contractor

- 3.1.1. The Contractor shall design, execute, and complete the works in accordance with the Contract and with the Project Manager's instructions, and shall remedy any defects in the works.
- 3.1.2. The Contractor shall provide all documents specified in the Contract, and all Contractor's personnel, goods, consumables, and other things and services, whether of a temporary or permanent nature, required in and for the design, execution, and completion of Works and remedying of defects.
- 3.1.3. The Contractor shall be responsible for the adequacy, stability, and safety of all site operations and all methods of construction. The Contractor (i) shall be responsible for all Contractor's documents, temporary works, and such design of each item of Works, equipment, or materials as is required for the item to be in accordance with the contract and (ii) shall not otherwise be responsible for the design or specification of the permanent works.
- 3.1.4. The Contractor shall, whenever required by the Project Manager, submit details of the arrangements and methods which the Contractor proposes to adopt for the execution of the works. No significant alteration to these arrangements and methods shall be made without this having previously been notified to the Project Manager.
- 3.1.5. If the Contract specifies that the Contractor shall design any part of the permanent works, then unless otherwise stated:
- a) The Contractor shall submit to the Project Manager the Contractor's documents for this part in accordance with the procedures specified in the Contract;
 - b) The Contractor's documents, in this regard, shall be in accordance with the specification and drawings, shall be written in the language for communications defined in GCC 1.4, and shall include additional information required by the Project Manager to add to the drawings for co-ordination of each party's designs;
 - c) The Contractor shall be responsible for this part and it shall, when the works are completed, be fit for such purposes for which the part is intended as are specified in the Contract; and
 - d) Prior to the commencement of the tests on completion, the Contractor shall submit to the Project Manager the "as-built" documents and operation and maintenance manuals in accordance with the specification and sufficient detail for the Project Manager to operate, maintain, dismantle, reassemble, adjust and repair this part of the Works. Such part shall not

be considered to be completed for the purpose of taking over under GCC.9.2 until these documents and manuals have been submitted to the Project Manager.

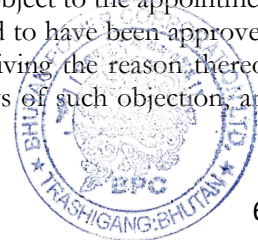
- 3.1.6. Within 14 days of possession of site, the Contractor shall erect an information board as specified in SCC and construct a permanent board towards the completion of the Project.

3.2. Performance Security

- 3.2.1. The Contractor shall, within Seven (7) days of the Notification of Award, provide a performance security equivalent to ten percent (10 %) of the Contract Price valid until specified in SCC. However, in case of delay in completion of the Contract, the validity of the contract performance security shall be extended by the Contractor for such period of delay. An employer shall encash the performance security to avoid it becoming invalid in case of failure by the Contractor to extend the validity before 7 days of expiry.
- 3.2.2. For Contracts not deducting retention money if specified in SCC, the Contractor shall extend the validity of the performance security until 30 days beyond the defect liability period (DLP) before the release of final bill payment. In case of failure to extend, Employer shall withhold from final payment equivalent to 10 % of the executed Contract price or the total final payment, in lieu of retention money. If the executed Contract price exceeds the Contract price, then retention money equivalent to 10 % of the exceeded amount in addition to the performance security already submitted shall be deducted from the running bills and retained until 30 days beyond DLP.
- 3.2.3. The performance security shall be denominated in the currency or currencies of the Contract or a freely convertible currency acceptable to the Employer and shall be in the form specified in SCC, issued/enforceable by any financial institution.
- 3.2.4. The performance security shall be discharged and returned to the Contractor within thirty (30) days after the issuance of the Work completion certificate/no defects liability certificate, whichever is applicable.
- 3.2.5. The proceeds from the Performance Security shall be payable to the Employer as compensation for any loss resulting from the Contractor's failure to complete its obligations under the Contract.

3.3. Contractor's Representative and Construction Manager

- 3.3.1. If the Contractor's Representative is not named in the Contract, then within fourteen (14) days of the Effective Date, the Contractor shall appoint his representative and shall request the Employer in writing to approve the person so appointed. If the Employer does not object to the appointment within fourteen (14) days, the Contractor's Representative shall be deemed to have been approved. If the Employer objects to the appointment within fourteen (14) days giving the reason thereof, then the Contractor shall appoint a replacement within fourteen (14) days of such objection, and the foregoing provisions of this clause 3.3.1 shall apply thereto.



- 3.3.2. The Contractor's Representative shall represent and act for the Contractor at all times during the currency of the Contract and shall give to the Project Manager all the Contractor's notices, instructions, information, and all other communications under the Contract.
- 3.3.3. All notices, instructions, information, and all other communications given by the Employer or the Project Manager to the Contractor under the Contract shall be given to the Contractor's Representative or, in its absence, its deputy, except as herein otherwise provided.
- 3.3.4. The Contractor shall not revoke the appointment of the Contractor's Representative without the Employer's prior written consent, which shall not be unreasonably withheld. If the Employer consents thereto, an equivalently qualified, experienced, and competent replacement shall be appointed pursuant to the procedure set out in 3.3.1 3.3.1.
- 3.3.5. The Contractor's Representative may, subject to the approval of the Employer (which shall not be unreasonably withheld), at any time delegate to any person any of the powers, functions, and authorities vested in him or her. Any such delegation may also be revoked at any time subject to the approval of the Employer. Any such delegation or revocation shall be subject to a prior notice signed by the Contractor's Representative and shall specify the powers, functions, and authorities thereby delegated or revoked. No such delegation or revocation shall take effect unless and until a copy thereof has been delivered to the Employer and the Project Manager.
- 3.3.6. Any act or exercise by any person of powers, functions, and authorities so delegated to him or her in accordance with this clause 3.3.53.3.5 shall be deemed to be an act or exercise by the Contractor's Representative.
- 3.3.7. From the commencement of Works at the Site until operational acceptance, the Contractor's Representative shall appoint a suitable person as the construction manager (hereinafter referred to as "the Construction Manager"). The Construction Manager shall supervise all work done at the Site by the Contractor and shall be present at the Site throughout normal working hours except when on leave, sick, or absent for reasons connected with the proper performance of the Contract. Whenever the Construction Manager is absent from the Site, an equivalently qualified, experienced, and competent person shall be appointed to act as his or her deputy.
- 3.3.8. Employer may by notice to the Contractor object to any representative or person employed by the Contractor in the execution of the Contract who, in the reasonable opinion of Employer, may behave inappropriately, may be incompetent or negligent, or may commit a serious breach of the Site regulations provided under GCC 3.8 Employer shall provide evidence of the same, whereupon the Contractor shall remove such person from the Site.
- 3.3.9. If any representative or person employed by the Contractor is removed in accordance with 3.3.83.3.8, the Contractor shall, where required, promptly appoint a replacement.
- 3.3.10. If any dispute of any kind whatsoever arises between Employer and the Contractor in connection with or arising out of the Contract, including without prejudice to the generality of the foregoing, any question regarding its existence, validity or termination, or the execution of the works –

whether during the progress of the works or after their completion and whether before or after the termination, abandonment or breach of the Contract – the parties shall seek to resolve any such dispute or difference by mutual consultation.

3.4. Opportunities for other Contractors

- 3.4.1. The Contractor shall, upon written request from the Employer or the Project Manager, provide a reasonable opportunity to other Contractors employed by the Employer to carry out the work at or near the Site. If the Contractor so requires, the Employer shall facilitate the Contractor to make use of the facilities created by other Contractors in and around the site, for execution of the Contract. In the process of and as a result of using such facilities, if any damage is caused to the Works, the Contractor shall be responsible for making good such damage at his own cost.
- 3.4.2. If the Contractor, upon written request from the Employer or the Project Manager, makes available to other Contractors any roads or access ways, (the maintenance for which the Contractor is responsible), permits the use by such other Contractors of the Contractor's Equipment, or provides any other service of whatsoever nature to such other Contractors, Employer shall fully compensate the Contractor for any loss or damage caused or occasioned by such other Contractors in respect of any such use or service and shall pay to the Contractor a reasonable remuneration for the use of such equipment or the provision of such services.
- 3.4.3. The Contractor shall also arrange to perform its work to minimize, to the extent possible, interference with the work of other Contractors. The Project Manager shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors and the workers of the Employer with regard to their work.
- 3.4.4. The Contractor shall notify the Project Manager promptly of any defects in the other Contractors' work that come to its notice, and that could affect the Contractor's work. The Project Manager shall determine the corrective measures, if any, required to rectify the situation after inspection of the Works. Decisions made by the Project Manager shall be binding on the Contractor.

3.5. Emergency Work

- 3.5.1. If, for reason of an emergency arising during the execution of the Contract, any protective or remedial work is necessary as a matter of urgency to prevent damage to the Works, the Contractor shall immediately carry out such work.
- 3.5.2. If the Contractor is unable or unwilling to do such work immediately, the Employer may do or cause such work to be done, as it may determine it necessary in order to prevent damage to the Works. In such event Employer shall, as soon as practicable after the occurrence of any such emergency, notify the Contractor in writing of such emergency, the work done, and the reasons thereof. If the work done or caused to be done by Employer is work that the Contractor was liable to do at its own expense under the Contract, the reasonable costs incurred by Employer in connection therewith shall be paid by the Contractor to Employer.

3.6. Progress Review Meetings

- 3.6.1. The Contractor shall attend all periodic progress review meetings organized by the Project Manager or his authorized representative. The deliberations in the meetings shall inter-alia include the scheduled program, progress of work achieved (including details of manpower, tools, and plants deployed by the Contractor vis-a-vis agreed work schedule), inputs to be provided by the Employer, delays, if any, and recovery programme, specific hindrances to the Works and work instructions by the Project Manager. The minutes of such meetings shall be prepared by the Project Manager. These minutes shall be jointly signed by the Project Manager or his authorized representative and the Contractor and one copy of the signed minutes shall be handed over to the Contractor.

3.7. Protection of the Environment

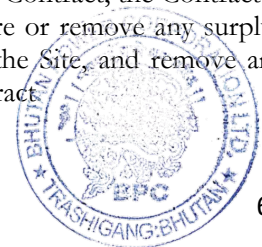
- 3.7.1. The Contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or property of the public or others resulting from pollution, noise, or other causes arising as a consequence of his methods of operation, and shall preserve and protect all existing vegetation and trees on or adjacent to the Site which does not unreasonably interfere with the execution of the Works. The Contractor shall be held responsible for all unauthorized cutting of and damage to trees, by careless operation of his plant, equipment, or materials and stockpiling of materials, etc. and the Employer shall have no responsibility on this account.

3.8. Site Regulations and Safety

- 3.8.1. Employer and the Contractor shall establish Site regulations setting out the rules to be observed in the execution of the Contract at the Site and shall comply therewith. The Contractor shall draft site regulations and submit a copy to the Project Manager, Employer for his approval, which approval shall not be unreasonably withheld. Notwithstanding the approval of the Project Manager, the Contractor shall be responsible for the adequacy, stability, and safety of all Site operations and methods of execution of the Contract.
- 3.8.2. Such Site regulations shall include, but shall not be limited to, rules with respect to security, safety of the Works, gate control, sanitation, medical care, and fire prevention.

3.9. Site Clearance

- 3.9.1. Site Clearance in course of performance: In the course of carrying out the Contract, the Contractor shall keep the Site reasonably free from all unnecessary obstruction, store or remove any surplus materials, clear away any wreckage, rubbish, or temporary works from the Site, and remove any Contractor's Equipment no longer required for the execution of the Contract.



- 3.9.2. Clearance of Site after completion: After completion of all parts of the Works, the Contractor shall clear away and remove all wreckage, rubbish, and debris of any kind from the Site, and shall leave the Site and Works clean and safe to the satisfaction of the Project Manager, without which the final bill shall be withheld.

3.10. Watching and Lighting

- 3.10.1. The Contractor shall provide and maintain at its own expense all lighting, fencing, and watching when and where necessary for the proper execution and the protection of the Works, or for the safety of the owners and occupiers of adjacent property and the safety of the public.

3.11. Explosives

- 3.11.1. Permission for the use of explosives shall be obtained from the Project Manager or from any appropriate authority as directed by the Project Manager and all explosive materials shall be used only under close supervision. It shall be the responsibility of the Contractor to seek and obtain any necessary permits and to ensure that the requirements of the authorities are complied with, in all respects. Failure to do so may result in the Project Manager withdrawing permission to use explosives. The indemnification provided shall include indemnification against all claims in respect of any incident arising from the use of explosives.

3.12. Temporary Utilities

- 3.12.1. The Contractor, except as stated in SCC, be responsible for the provision of all temporary utilities, including electricity, gas, telecommunication, drinking water, construction water, and any other services the Contractor may require for the execution of the Works.

3.13. Working hours

- 3.13.1. Unless otherwise provided in the Contract, no work shall be carried out during the night and on public holidays of the Kingdom of Bhutan without prior written consent of Employer, except where work is necessary to ensure the safety of the Works, for the protection of life, or to prevent loss or damage to property. Where work is needed to be carried out during public holidays, the Contractor shall immediately advise the Project Manager and seek his advice and consent. However, the provisions of this clause shall not apply to any work, which is customarily carried out in multiple shifts. Notwithstanding the above provisions, female labour shall not be employed in night shifts.
- 3.13.2. Notwithstanding 3.13.1 or 5.15.2, if and when the Contractor considers it necessary to carry out work at night or on public holidays to meet the Time for Completion and requests the Employer's consent thereto, the Employer shall not unreasonably withhold such consent.



3.14. Program of Performance

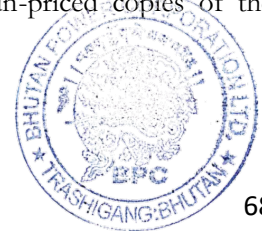
- 3.14.1. Within twenty-eight (28) days of the Effective Date, the Contractor shall prepare and submit in soft copies to the Project Manager for his approval a detailed program of performance of the Contract, made in the form of PERT network (prepared in the software as may be directed by Employer) and showing the sequence in which it proposes to design, execute and complete the Works as well as the date(s) by which the Contractor reasonably requires that Employer shall have fulfilled its obligations under the Contract to enable the Contractor to execute the Contract in accordance with the program and to achieve completion of the Works in accordance with the Contract. The Contractor shall update and revise the program as and when appropriate or when required by the Project Manager, but without modification in the Time for Completion given in the SCC and any extension granted in accordance with GCC 8.3, and shall submit all such revisions to the Project Manager for his approval.

3.15. Progress of Performance

- 3.15.1. If at any time the Contractor's actual progress falls behind the program referred to in 3.14.3.14.1, or it becomes apparent that it shall so fall behind, the Contractor shall, at the request of Employer or the Project Manager, prepare and submit to the Project Manager a revised program, taking into account the prevailing circumstances, and shall notify the Project Manager of the steps being taken to expedite progress so as to attain completion of the Works within the Time for Completion under GCC 8.1, any extension thereof entitled under GCC 8.3.1, or any extended period as may otherwise be agreed upon between Employer and the Contractor.

4. Subcontracting

- 4.1. The Contractor shall not Sub-Contract any part of the Contract or any part of the scope of work under the Contract, without the explicit and written approval of the Employer.
- 4.2. Where sub-contracting is allowed and approved, the Contractor shall prepare a list of subcontractors with the approval of the Employer. The Contractor may propose any addition to or deletion from any such list. The Contractor shall submit any such list or any modification thereto to the Employer for its approval in sufficient time so as not to impede the progress of Works. Such approval by the Employer for any of the subcontractors shall not relieve the Contractor from any of its obligations, duties, or responsibilities under the Contract.
- 4.3. The Contractor shall be responsible fully for the acts, defaults, and negligence of his sub-contractors, their agents, servants, and workmen as if such acts, defaults, and negligence are of the Contractor. The Contractor shall be under obligation to furnish the un-priced copies of the Contracts awarded to the sub-contractors at the request of the Employer.



5. Contractor's Staff/Labour and Equipment

5.1. Key Personnel

- 5.1.1. The Contractor shall employ the key personnel named in the Schedule of Key Personnel, as referred to in the SCC, to carry out the functions stated in the Schedule or other personnel approved by the Project Manager. The Project Manager shall approve any proposed replacement of key personnel only if their relevant qualifications and abilities are substantially equal to or better than those of the personnel listed in the Schedule. If the Contractor fails to deploy the personnel as committed in the Bidding Document, the employer shall stop the work if the quality of work is going to suffer or otherwise deduct the salaries of such personnel at a rate stipulated in the SCC per month per personnel for every month of an absence of such personnel from the site. Such deductions shall continue till such time that the Contractor deploys the key personnel acceptable to the employer. If the Contractor fails to deploy such key personnel within one to four months, the deductions may be discontinued and the Contractor's failure to deploy such personnel shall be treated as a fundamental breach of Contract. This shall also apply to the commitment of employment to Bhutanese.

5.2. Labour

- 5.2.1. The Contractor shall provide and employ on the Site in the execution of the Works such skilled, semi-skilled, and unskilled labour as is necessary for the proper and timely execution of the Contract. The Contractor is encouraged to use local labour that has the necessary skills.
- 5.2.2. Unless otherwise provided in the Contract, the Contractor shall be responsible for the recruitment, transportation, accommodation, medical care, and catering of all labour, local or expatriate, required for the execution of the Contract and all payments in connection therewith.
- 5.2.3. The Contractor shall be responsible, at his own cost, for obtaining all necessary permit(s) and/or visa(s) from the appropriate authorities for the entry of all labour and personnel to be employed on the Site into the Kingdom of Bhutan. The Contractor shall submit to the Employer for its approval details and bio-data of all expatriate personnel, whom he proposes to engage for the performance of Works under the Contract, at least sixty (60) days before they depart for Bhutan. Such data for each personnel shall contain, among other details, his name, present address, assignment and responsibility in connection with the Works, and a short resume of his qualifications, experience, etc. in relation to the works to be performed by him.
- 5.2.4. Any expatriate personnel deployed for the Works at Site, if found unsuitable or unacceptable later on to RGoB/ Employer, shall within a reasonable time, be repatriated by the Contractor, who shall make alternative arrangements for providing a suitable replacement.
- 5.2.5. The Contractor shall at its own expense provide the means of repatriation to all of its and its subcontractor's personnel employed on the Contract at the Site to their various home countries. It



shall also provide suitable temporary maintenance of all such persons from the cessation of their employment on the Contract to the date programmed for their departure. If the Contractor defaults in providing such means of transportation and temporary maintenance, the Employer may provide the same to such personnel and recover the cost of doing so from the Contractor.

- 5.2.6. No person brought to Bhutan for the completion of Works shall be repatriated without the consent of the Project Manager on a written request from the Contractor for such repatriation giving reasons thereof. The Project Manager may permit such repatriation provided it is satisfied that the progress of Works shall not suffer due to such repatriation/replacement.
- 5.2.7. The Contractor shall at all times during the progress of the Contract use its best endeavors to prevent any unlawful, riotous, or disorderly conduct or behavior by or amongst its employees and the labour of its subcontractors for the preservation of peace and protection of persons and property at the Site and its surroundings.
- 5.2.8. In dealing with the labourers and workers engaged at the Works by him or his sub-Contractors, the Contractor shall pay due regard to all recognized festivals, holidays, traditions, and cultures of the labourers. The Contractor shall also comply with all local laws and regulations pertaining to labour and expatriate personnel issued by the Ministry of Home and Cultural Affairs, RGOB. The Contractor shall indemnify the Employer in respect of all claims that may be made against the Employer for non-compliance thereof by the Contractor. In case of non-compliance by the Contractor, the Project Manager may take such actions as may be necessary for compliance with the various labour laws and recover the costs thereof from the Contractor.
- 5.2.9. The Contractor shall deliver to the Project Manager or to the Project Manager's representative, a report in such form and at such intervals as the Project Manager may prescribe, regarding the number and names of supervisory staff and different categories of labour engaged by the Contractor.

5.3. Contractor's Equipment

- 5.3.1. All the equipment brought by the Contractor onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Contractor shall not remove the same from the Site without the Project Manager's consent stating that the equipment is no longer required for the execution of the Contract.
- 5.3.2. The Contractor shall deploy construction equipment as per the agreed schedule. Provided further that in case of slow rate of progress of Works, the Contractor should supplement the agreed schedule of Contractor's Equipment with additional construction equipment to ensure completion of Works within Time for Completion at no extra cost to Employer.
- 5.3.3. If the Contractor does not make available at the site the equipment committed for the Contract, the hiring charges of such equipment shall be deducted at a rate stipulated in the SCC per month



for every month of absence for a period of up to four months after which the deductions shall be discontinued and the Contractor's failure to produce such equipment at site shall be treated as a fundamental breach of Contract.

- 5.3.4. Unless otherwise specified in the Contract, upon completion of the Works, the Contractor shall remove from the Site all Contractor's Equipment brought by the Contractor onto the Site and any surplus materials remaining thereon.
- 5.3.5. An employer may, if requested, use its best endeavours to assist the Contractor in obtaining any government permission required by the Contractor for the export of the Contractor's Equipment imported by the Contractor for use in the execution of the Contract that is no longer required for the execution of the Contract.

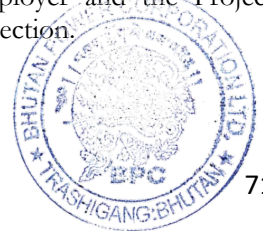
6. Plant, Material, and Workmanship

6.1. Methodology of Construction & Equipment Mobilization

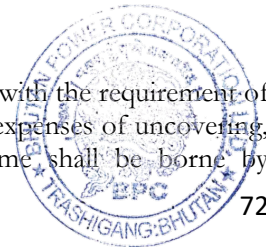
- 6.1.1. The methodology of construction and the work plan adopted by the Contractor shall match the construction methodology/requirements specified in the Technical Specifications. The suggested minimum plant & equipment and machinery to be deployed by the Contractor for the execution of Works shall be as given in Technical Specifications. The Contractor shall arrange at his own expense all tools, plant, and equipment required for execution of the Works.

6.2. Test and Inspection

- 6.2.1. The Contractor shall at its own expense carry out at the place of manufacture and/or on the Site all such tests and/or inspections of the plant, materials, and any part of the Works as specified in the Contract.
- 6.2.2. Employer and the Project Manager or their designated representatives shall be entitled to attend the aforesaid test and/or inspection, provided that Employer shall bear all costs and expenses incurred in connection with such attendance including, but not limited to, all traveling and boarding & lodging expenses.
- 6.2.3. Whenever the Contractor is ready to carry out any such test and/or inspection, the Contractor shall give reasonable advance notice of such test and/or inspection and of the place and time thereof to the Project Manager. The Contractor shall obtain from any relevant third party or manufacturer any necessary permission or consent to enable the Employer and the Project Manager (or their designated representatives) to attend the test and/or inspection.



- 6.2.4. The Contractor shall provide the Project Manager with a certified report of the results of any such test and/or inspection.
- 6.2.5. If the Employer or Project Manager (or their designated representatives) fails to attend the test and/or inspection, or if it is agreed between the Parties that such persons shall not do so, then the Contractor may proceed with the test and/or inspection in the absence of such persons, and may provide the Project Manager with a certified report of the results thereof.
- 6.2.6. The Project Manager may require the Contractor to carry out any test and/or inspection not required by the Contract, provided that the Contractor's reasonable costs and expenses incurred in the carrying out of such test and/or inspection shall be added to the Contract Price. Further, if such test and/or inspection impede the progress of Works and/or the Contractor's performance of its core obligations under the Contract, due allowance shall be made in respect of the Time for Completion and the other obligations so affected.
- 6.2.7. If any part of the Works fails to pass any test and/or inspection, the Contractor shall either rectify or replace such part of the Works and shall repeat the test and/or inspection upon giving a notice in accordance with clause 6.2.36.2.3.
- 6.2.8. If any dispute or difference of opinion shall arise between the Parties in connection with or arising out of the test and/or inspection of any part of the Works that cannot be settled between the Parties within a reasonable period of time, it may be referred to the Adjudicator for determination in accordance with 3.2.
- 6.2.9. The Contractor agrees that neither the execution of a test and/or inspection of plant, equipment, or any part of the Works, nor the attendance by Employer or the Project Manager, nor the issue of any test certificate pursuant to 6.2.4, shall release the Contractor from any other responsibilities under the Contract.
- 6.2.10. No part of the Works or foundations shall be covered up on the Site without the Contractor carrying out any test and/or inspection required under the Contract. The Contractor shall give reasonable notice to the Project Manager whenever any such part of the Works or foundations is ready or about to be ready for test and/or inspection; such test and/or inspection and notice thereof shall be subject to the requirements of the Contract. The Project Manager shall then without unreasonable delay carry out the test/inspection or measurement.
- 6.2.11. The Contractor shall uncover any part of the Works or shall make openings in or through the same as the Project Manager may from time to time require at the Site, and shall reinstate and make good such part or parts.
- 6.2.12. If any part of the Works have been covered up at the Site after compliance with the requirement of 6.2.10 and are found to be executed in accordance with the Contract, the expenses of uncovering, making openings in or through, reinstating, and making good the same shall be borne by



Employer, and the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been delayed or impeded in the performance of any of its obligations under the Contract.

7. Work Execution

7.1. Benchmark

7.1.1. The Contractor shall be responsible for the true and proper setting-out of the Works in relation to benchmarks, reference marks, and lines provided to it in writing by or on behalf of the Employer.

7.1.2. If, at any time during the progress of Works, any error shall appear in the position, level, or alignment of the Works, the Contractor shall forthwith notify the Project Manager of such error and, at its own expense, immediately rectify such error to the reasonable satisfaction of the Project Manager. If such error is based on incorrect data provided in writing by or on behalf of Employer, the expense of rectifying the same shall be borne by Employer. The checking of any benchmark by the Project Manager shall not relieve the Contractor of his responsibility.

7.2. Contractor's Supervision

7.2.1. The Contractor shall give or provide all necessary superintendence during the execution of Works, and the Construction Manager or its deputy shall be on the Site to provide full-time superintendence of the execution as long as the Project Manager may consider necessary for the proper fulfillment of the Contractual obligations. The Contractor shall provide and employ only technical personnel who are skilled and experienced in their respective callings and supervisory staff who are competent to adequately supervise the work at hand.

7.3. Quality Assurance Program

7.3.1. Sampling, testing, and quality assurance requirements shall be as per the details given in Technical Specifications. All costs associated with testing of materials required as per Technical Specifications shall be deemed to be included in the rates/prices in the Bill of Quantities.

7.4. Progress Report

7.4.1. The Contractor shall monitor the progress of all the activities specified in the program referred to in 3.14 above, and supply a progress report to the Project Manager every month.

7.4.2. The progress report shall be in a form acceptable to the Project Manager and shall include, among other details: (a) percentage completion achieved vis-à-vis planned activities; and (b) where any activity is behind schedule providing reasons and likely consequences and stating the corrective

action being taken. The progress report shall be supported by photographs and other written material as the Project Manager may direct.

7.5. Materials obtained from the excavation

- 7.5.1. Materials of any kind obtained from excavation on the Site shall remain the property of the Employer and shall be disposed of as the Project Manager may direct.
- 7.5.2. All fossils, coins, articles of value or antiquity, structures and other remains or things of geological or archaeological interest discovered on the Site shall be the absolute property of the Employer and the Contractor shall take reasonable precautions to prevent his workmen or any other person from removing or damaging any such article or thing. Upon discovery and before removal of such items or structures, the Contractor shall immediately inform the Project Manager and shall dispose of the same as per the direction of the Project Manager and at the cost of the Employer.

8. Commencement, Delays and Suspension

8.1. Time for commencement and completion

- 8.1.1. The Works must be taken up and completed in all respects within the specified time of completion as mentioned in the SCC and the NoA.
- 8.1.2. Before the actual commencement of works, the Contractor shall submit an execution schedule of work clearly showing the materials, men, and equipment to be mobilized by him to execute the works. The schedule should contain the planned monthly progress of the works for the approval of the Project Manager who shall have the authority to make additions, alternations, and substitutions to such schedule in consultation with the Contractor.

8.2. Manner of Execution

- 8.2.1. The Contractor shall carry out all aspects of the Works in the manner (if any) specified in the Contract:
 - a) In a proper workmanlike and careful manner with a high sense of aesthetics and in accordance with recognized good practice; and
 - b) With properly equipped facilities and using non-hazardous materials, except as otherwise specified in the Contract.
- 8.2.2. Within thirty (30) days of the Effective Date, the Contractor shall prepare and submit in soft copies to the Project Manager for his approval a detailed construction schedule showing the sequence and interdependence of activities and work breakdown structure covering all the activities

to meet milestone schedules for complete performance of work, starting from the commencement date to completion within the Time for Completion.

- 8.2.3. The detailed construction schedule shall include time-scaled network diagrams and Gantt charts, based on calendar days. It shall be constructed to show the order in which the Contractor proposes to carry out the work and the availability/requirement and use of manpower, materials, and construction equipment. The Contractor shall utilize the detailed construction schedule in planning, scheduling, monitoring, coordinating, and performing the Works under the Contract (including activities of subcontractors, plant vendors, material suppliers, etc.). The program so submitted by the Contractor shall be in accordance with the Contract.
- 8.2.4. The Project Manager and Contractor shall meet within seven (7) days of the submittal of the detailed construction schedule to review and make any necessary adjustments or revisions. The Contractor shall submit the revised schedule within seven (7) days of re-submission. The process of finalizing the detailed construction schedule shall be completed within sixty (60) days from the date of issue of Notification of Award. The detailed construction schedule, once approved by the Employer, shall become the baseline record schedule. The baseline detailed construction schedule shall be used for all monitoring and evaluation of the Contractor's performance.
- 8.2.5. The Contractor shall update and revise the schedule as and when appropriate or when required by the Project Manager, but without modification in the Time for Completion and any extension granted, and shall submit all such revisions to the Project Manager for his approval.
- 8.2.6. If at any time the Contractor's actual progress falls behind the program, or it becomes apparent that it shall so fall behind, the Contractor shall, at the request of Employer or the Project Manager, prepare and submit to the Project Manager a revised program, taking into account the prevailing circumstances, and shall notify the Project Manager of the steps being taken to expedite progress so as to attain completion of the Works within the Time for Completion, any extension thereof entitled, or any extended period as may otherwise be agreed upon between Employer and the Contractor.

8.3. Extension of Time for Completion

- 8.3.1. The Time(s) for Completion specified in the SCC shall be extended if the Contractor is delayed or impeded in the performance of any of its obligations under the Contract because of any of the following:
- a) Any Change in the Works as provided in GCC 12.2;
 - b) Any occurrence of Force Majeure as provided in GCC 16
 - c) Any suspension order given by Employer under GCC 14.5 hereof or reduction in the rate of progress pursuant to 14.5.4;
 - d) Any changes in laws and regulations as provided in GCC 12.7.1
 - e) Any default or breach of the Contract by Employer, specifically including failure to supply agreed items or any activity, act, or omission of any other Contractors employed by Employer; or

f) Any other matter specifically mentioned in the Contract.

8.3.2. Extension of time shall be for such period as shall be fair and reasonable in all the circumstances and as shall fairly reflect the delay or impediment sustained by the Contractor.

8.3.3. Except where otherwise specifically provided in the Contract, the Contractor shall submit to the Project Manager a notice of a claim for an extension of the Time for Completion, together with particulars of the event or circumstance justifying such extension as soon as reasonably practicable after the commencement of such event or circumstance. As soon as reasonably practicable after receipt of such notice and supporting particulars of the claim, the Employer and the Contractor shall agree upon the period of such extension. If the Contractor does not accept the Employer's estimate of a fair and reasonable time extension, the Contractor shall be entitled to refer the matter to the Adjudicator, pursuant to 3.2.

8.3.4. In no case, the extension in Time for Completion shall be permitted for the defaults on the part of the Contractor.

8.4. Liquidated Damages

8.4.1. The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the SCC for each day that the Completion Date is later than the Intended Completion Date. The total amount of liquidated damages shall not exceed ten percent (10 %) of the executed Contract Price. The Employer may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities.

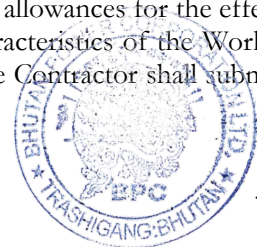
9. Taking Over

9.1. Test on Completion

9.1.1. The Contractor shall carry out the tests on completion in accordance with clause GCC 6.2.

9.1.2. The Contractor shall provide the Project Manager with a minimum of twenty-one (21) days' notice of the date after which the Contractor shall be ready to carry out each of the tests on completion. Unless otherwise agreed, tests on completion shall be carried out within fourteen (14) days after the notice period on such day or days, as the Project Manager shall instruct.

9.1.3. In considering the result of the tests on completion, Employer shall make allowances for the effect of any use of the Works by Employer on the performance or other characteristics of the Works. As soon as the Works, or a part, have passed any tests on completion, the Contractor shall submit a certified report of the results of these tests to the Employer.



- 9.1.4. If the tests on completion are being unduly delayed by the Contractor, the Employer may by notice require the Contractor to carry out the tests within twenty-one (21) days after receiving the notice. The Contractor shall carry out the tests on such day or days within that period as the Contractor may fix and of which he shall give notice to the Employer.
- 9.1.5. If the Contractor fails to carry out the tests on completion within twenty-one (21) days, the Employer's personnel may proceed with the tests at the risk and cost of the Contractor. The tests on completion shall then be deemed to have been carried out in the presence of the Contractor and the result of the tests shall be accepted as accurate.
- 9.1.6. If the Works, or a part, fail to pass the tests on completion, the Employer may require the failed tests on completion on any related work, to be repeated under the same terms and conditions.
- 9.1.7. If the Works, or a part, fail to pass the tests on completion repeated under GCC.9.1 above, the Project Manager shall be entitled to:
- a) order further repetition of tests on completion as provided under GCC.9.1;
 - b) reject the Works if the effect of the failure is to deprive Employer of substantially the whole benefits of the Works in which event Employer shall have the same remedies as are provided in GCC 10.3.3 (c);
 - c) issue a Taking-Over Certificate, if the Employer so requests.

9.2. Taking Over Works

- 9.2.1. The Works shall be taken over by Employer upon successful execution of Works by the Contractor in accordance with provisions of Contract.
- 9.2.2. On successful completion of Works or any part thereof and upon request of the Contractor for taking over the Works and issuance of Taking Over Certificate (TOC), Employer shall, within forty-five (45) days after the receipt of the Contractor's application, or within fifteen (15) days from the date of actual handing over of relevant Works, whichever is later, either issue the TOC or reject the application giving its reasons and specifying the work required to be done by the Contractor to enable the TOC to be issued.
- 9.2.3. TOC shall be issued to the Contractor specifying the date on which the Works or any part thereof was complete and ready for taking over, after ascertaining the following:
- a) The Works have been satisfactorily completed by the Contractor as per the provisions of the Contract.
 - b) The Contractor has cleared the Site of all the surplus materials, removed all scaffoldings, shuttering materials, labour huts/sheds, cleaned the dirt from the Site, temporary sanitary and water supply arrangements, and all electrical gadgets/ equipment/ switches, wiring, any

woodwork or any such item, as relevant to the Contract to the satisfaction of the Project Manager, except those required for carrying out rectification works.

c) All the defects have been rectified to the complete satisfaction of the Project Manager.

9.2.4. Issuance of such certificates shall not relieve the Contractor of any of his obligations which otherwise were to be complied with under the terms and conditions of the Contract.

9.2.5. Notwithstanding the above-mentioned provisions, the issuance of TOC shall not be held up due to a delay in completion/ rectification of works of minor nature that do not affect the performance/ use of the Works. In such a case the Contractor shall, however, be required to give an undertaking stating that in case he fails to complete/rectify the defects within a mutually agreed period, the Employer shall be at liberty to carry out the work at his risk and cost and deduct an amount as may be considered appropriate by Employer.

9.2.6. Issuance of TOC for any part of the Works is only to facilitate the Contractor to receive the payment for part of the Works completed and for determination of liquidated damages in respect thereof and shall not relieve the Contractor of his responsibilities under the Contract towards other parts of the Works.

9.2.7. At the time of taking over the work, the Project Manager shall ensure that the Contractor constructs a permanent information board as specified in SCC.

9.3. Operating and Maintenance Manuals

9.3.1. If “as built” Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the SCC.

9.3.2. If the Contractor does not supply the Drawings and/or manuals by the dates stated in the SCC, or they do not receive the Project Manager’s approval, the Project Manager shall withhold the amount stated in the SCC from payments due to the Contractor.

10. Defects

10.1. Correction of Defects

10.1.1. The Project Manager shall check the Contractor’s work and notify the Contractor of any Defects that are found. The Project Manager shall give notice to the Contractor of any Defects before the end of the Defects Liability Period (DLP), which begins at Completion and is defined in the SCC. Every time notice of a Defect is given; the Contractor shall correct the notified Defect within the length of time specified by the Project Manager’s notice.

10.2. Uncorrected Defects



- 10.2.1. If the Contractor has not corrected a Defect within the time specified in the Project Manager's notice, the Project Manager shall assess the cost of having the Defect corrected, and the Contractor shall pay this amount to the Employer. At the option of the Employer, payment of such costs may be made in whole or in part by the Employer deducting and keeping for itself appropriate amounts from the Retention Money and/or claiming against any bank guarantee provided by the Contractor.
- 10.2.2. The defects Liability Period shall be extended for as long as the defects remain to be corrected.

10.3. Defect Liability

- 10.3.1. If during the Defect Liability Period any defect is found in the design, engineering, materials, and workmanship of the Works executed by the Contractor, the Contractor shall promptly, in consultation and agreement with Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good such defect as well as any damage to the Works caused by such defect.
- 10.3.2. The Defect Liability Period shall be as specified in the SCC. Where any part of the Works is taken over separately, the Defects Liability Period for that part shall commence on the date it was taken over.
- 10.3.3. If the Contractor fails to commence the work necessary to remedy such defect or any damage to the Works caused by such defect within fifteen (15) days of the intimation of the defect and complete the remedying of such defect within the time specified by Employer, Employer reserves the right to get such work done in a manner as mentioned hereunder:
- a) carry out the work himself or by others, in a reasonable manner and at the Contractor's cost, but the Contractor shall have no responsibility for the work. The Contractor shall pay to Employer the costs reasonably incurred by Employer in remedying the defect or damage;
 - b) require the Project Manager to agree or determine a reasonable reduction in the Contract Price; or
 - c) if the defect or damage deprives Employer of substantially the whole benefit of the Works or any major parts of the Works, Employer may terminate the Contract as a whole, or in respect of such major part, which cannot be put to the intended use. Without prejudice to any other rights, under the Contract or otherwise, Employer shall then be entitled to recover all sums paid for the Works or such part (as the case may be), plus financing costs and the cost of dismantling the same, clearing the site and returning plant and materials to the

Contractor. If the Works or any part thereof cannot be used because of such defect and/or making good of such defect, the Defect Liability Period of the Works or such part, as the case may be, shall be extended by a period equal to the period during which the Works or such part cannot be used by Employer because of any of the aforesaid reasons. Upon correction of the defects in the Works or any part thereof by repair/replacement, such repair/replacement shall have the Defect Liability Period for twelve (12) months from the time such replacement/repair of the Works or any part thereof has been completed.

- 10.3.4. On completion of the Defect Liability period of the whole of the Works or where Works have been taken over in parts, the Employer shall issue a Defect Liability Certificate to the Contractor certifying the successful completion of the defect liability period.

11. Measurement and Valuation

- 11.1.** Except as otherwise stated in the Contract and notwithstanding local practice:

- 11.1.1. Measurement shall be made of the net actual quantity of each item of the Works, and

- 11.1.2. The method of measurement shall be in accordance with the BoQ, technical specifications, or other applicable schedules.

- 11.2.** Whenever the Employer requires any parts of the Works to be measured, reasonable notice shall be given to the Contractor's representative, who shall:

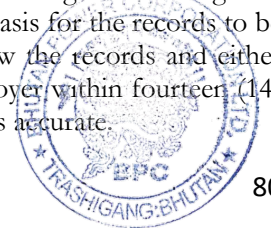
- 11.2.1. Promptly either attend or send a qualified representative to assist the Project Manager in making the measurement, and

- 11.2.2. Supply any particulars requested by the Project Manager.

- 11.3.** If the Contractor fails to attend or send a representative, the measurement made by (or on behalf of) the Employer shall be accepted as accurate.

- 11.4.** Except as otherwise stated in the Contract, wherever any Works are to be measured from records, these shall be prepared by the Employer. The Contractor shall, as and when requested, attend to examine and agree with the records with the Employer, and shall sign the same when agreed. If the Contractor does not attend, the records shall be accepted as accurate.

- 11.5.** If the Contractor examines and disagrees with the records, and/or does not sign them as agreed, then the Contractor shall give notice to the Employer citing the reasons/basis for the records to be allegedly inaccurate. After receiving this notice, the Employer shall review the records and either confirm or vary them. If the Contractor does not so give notice to Employer within fourteen (14) days after being requested to examine the records, they shall be accepted as accurate.



12. Variations and Adjustments

12.1. Contract Price Adjustment

- 12.1.1. The regulation and payment of Contract Price Adjustment under the Contract shall be governed by the provisions specified in the Bidding Documents. The Contract Price as awarded shall be the base Contract Price. A certain fixed percentage of the base Contract Price shall not be subject to any Contract Price Adjustment. The balance percentage to be specified shall be of identified components towards labour, material(s), and H.S. diesel oil, hereinafter called the variable component, shall be subject to Contract Price Adjustment.
- 12.1.2. The fixed component and the variable components shall be specified in SCC. The amount of Contract Price Adjustment payable/ recoverable for the work done during the relevant period shall be calculated as under:

$$CPA = ACP - BCP$$

Where,

CPA = Control Price Agreement

BCP = Base Contract Price

ACP = Adjusted Contract Price

ACP shall be computed as under:

$$ACP = BCP * \left[F + \frac{l * L_1}{L_0} + \frac{m * M_1}{M_0} + \frac{m * M_2}{M_0} \right]$$

$$F + l + m = 1$$

Where:

- F = Fixed component expressed in percentage of the Base Contract Price which shall not be subject to any adjustment as quantified and stipulated in the SCC, generally 20 %.
- L = Labour component expressed in percentage of the Base Contract Price which shall be subject to Price Adjustment as quantified and stipulated in the SCC, generally up to 15 % to 30 %
- M = Material component expressed in percentage (excluding material issued by Employer) of the Base Contract Price which shall be subject to Price Adjustment as quantified and stipulated in the SCC, generally 30 % to 60 %



L = Labour Index

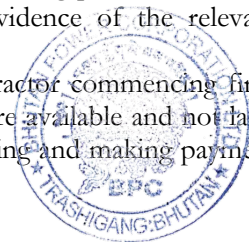
M = Material Index

SUBSCRIPT

'0' = refers to the value of the above-mentioned labour/ material indices as of thirty (30) days before the Bid opening date.

'1' = refers to the value of the corresponding labour/material indices as applicable for the preceding month in which the work is executed for which the adjustment is applicable, respectively.

- 12.1.3. The total amount payable on the Base Contract Price on account of the Contract Price Adjustment as indicated above shall not exceed the maximum of twenty percent (20 %) of the Contract Price as awarded.
- 12.1.4. Contract Price Adjustment(s) shall be calculated for the value of Works executed for the billing month as per the agreed work schedule. For payment/recovery of Price Adjustments, such payment/refund shall be operative and payable in accordance with the scheduled completion period (including authorized extensions, if any) or actual completion period, whichever is earlier. Provided further that the Contractor would be eligible for such price adjustment claims or shall be liable for a refund on the quantum of Works scheduled or the actual quantum of Works done provided always that the work done is more than or equal to the scheduled of work as per agreed work schedule.
- 12.1.5. The Contractor shall not be eligible for the payment of the price adjustment claims or liable for refund of Contract Price adjustment for the period beyond the scheduled date of execution of Works if the Works has been delayed beyond the scheduled date(s) for reasons attributable to the Contractor. However, for quantities of Works executed beyond the scheduled dates of execution, the Contractor would be liable for refund of Contract Price Adjustment(s) for such delayed Work based on the value of the indices as applicable to the scheduled dates of execution, provided that if the indices of the actual dates of execution are lower than the indices as on scheduled dates of execution, then lower indices shall be applicable. In cases where the execution of Works is delayed for reasons attributable to Employer, the Contractor shall be eligible for payment or refund of price adjustment on such delayed execution of Works based on the indices prevailing as on the date of execution of such Works.
- 12.1.6. Rates of items included in the Bill of Quantities, whose quantities have varied beyond the permissible deviation limits and rates of extra items, derived and agreed from items included in the Bill of Quantities shall also be subject to price adjustment as per this clause.
- 12.1.7. The Contractor shall, every month after commencement of the Works, submit to the Project Manager a written notice of the changes, if any, that have occurred in the specified indices of Materials, and Labour or that of Diesel price, etc. during the previous reporting period containing the effective date of such change, with authenticated documentary evidence of the relevant applicable published indices/diesel price, etc.
- 12.1.8. Monthly bills for Contract Price Adjustment shall be made by the Contractor commencing first, from the month when all the relevant/ applicable indices/ diesel prices are available and not later than fifteen (15th) days of every month thereafter. The period for processing and making payment



for these bills shall also be governed by the provisions as applicable to on-account/ progressive interim payments.

12.2. Change in Works

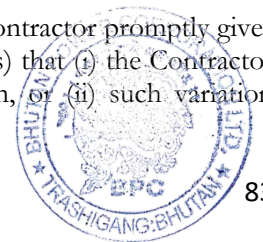
12.2.1. Introducing a Change

Employer shall have the right to propose, and subsequently require, that the Project Manager order the Contractor from time to time during the performance of the Contract to make any change, modification, addition, or deletion to, in, or from the Works in the form, quantity or quality of the Works or any part thereof (hereinafter called “Change”), provided that such Change falls within the general scope of the Works and does not constitute unrelated work and that it is technically practicable, taking into account both the state of advancement of the Works and the technical compatibility of the Change envisaged with the nature of the Works as specified in the Contract. Such changes shall include but not be limited to the following:

- a) Increase or decrease in the quantity of any work included in the Contract;
- b) Omission, insertion, or substitution of any item of work;
- c) Change in the drawings, designs, specifications, character or quality or kind of any such work;
- d) Change in the levels, lines, positions, and dimensions of any part of the Works;
- e) Additional work of any kind necessary for the completion of the Works;
- f) Change in any specified sequence, method, or timing of construction of any part of the Works.

12.2.2. An employer shall make any such variations by issuing written instructions to the Contractor and shall ensure that such variations are duly noted by the Contractor and the Project Manager. A variation made shall not, in any way, vitiate or invalidate the Contract, but the effect, if any, of such variations shall be valued.

12.2.3. The Contractor shall execute and be bound by each variation unless the Contractor promptly gives notice to the Employer stating (with supporting particulars and documents) that (i) the Contractor cannot readily obtain the goods and materials required for the variation, or (ii) such variation



triggers a substantial change in the sequence of the progress of the on-going works. Upon receipt of such a notice, the Employer shall cancel, confirm, or vary the instructions.

- 12.2.4. The Contractor may from time to time during its performance of the Contract, propose to the Employer (with a copy to the Project Manager) any Change that the Contractor considers necessary or desirable to improve the quality, efficiency, or safety of the Works. Employer may at its discretion approve or reject any Change proposed by the Contractor.
- 12.2.5. Notwithstanding 012.2.1 and 12.2.2 12.2.1(b), the change made necessary because of any default of the Contractor in the performance of its obligations under the Contract shall not be deemed to be a Change, and such change shall not result in any adjustment of the Contract Price or the Time for Completion.

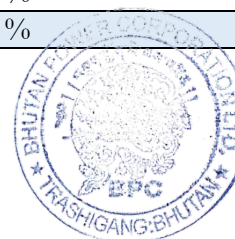
12.3. Variations in Contract

- 12.3.1. The Contractor shall be under obligation to agree to the Changes as may be required during the execution of the Contract as per directions of the Project Manager and execute such changes at the same rates included in the Contract, provided the total effect of such changes does not exceed the limit of plus/minus twenty percent ($\pm 20\%$) of the Contract Price. Such ceiling shall however be applicable only for items of work for which rates are provided in the Contract. Notwithstanding the aforesaid provision, the quantities for individual items, if specified in the Contract, can vary to any extent. No claim for revision of rates for any individual item in the Bill of Quantities shall be admissible irrespective of the extent to which the ordered quantity may get revised (+) or (-) during the actual execution of the Works. For Changes beyond twenty percent (20 %) of the Contract Price, the adjustment in the rates for Bill of Quantity items shall be made as per GCC.12.4. The procedure on how to proceed with and execute Changes is specified in GCC.12.4.

12.4. Adjustment of the Contract Price

- 12.4.1. If a reduction or increase in the Contract Price due to Change is found to be more than twenty percent (20 %) of the Contract Price, the Contract Price shall be adjusted as per the rates below:

Variation in value of Work	Increase in payment for minus variation	Decrease in payment for plus variation
Up to 20 %	Nil	Nil
Above 20 % & up to 35 %	6.00 %	3.00 %
Above 35 % & up to 60 %	8.00 %	4.00 %
Above 60 % & up to 100 %	10.00 %	5.00 %
Above 100 %		5.00 %



- 12.4.2. While working out the value of work for variation, the extra items for which new rates have been paid and payment towards price adjustment; and the adjustment towards statutory variations shall not be considered.

Illustration:

- a. In case of variation in the value of work by (plus) + sixty percent (60 %), the payment for (60-20) %, i.e., forty percent (40 %) of the value of work shall be decreased by four percent (4 %). The reduction in Contract rates shall commence as soon as the value of the work executed reaches 120 % of the Contract Price.

Award Value (AV) =100

Executed Value (EV)=160

Variation=+ 60 %

Final Payable= EV-((60-20) %*(4 %*160))

=160-((40 %*(4 %*160)) =160-2.56=157.44

- b. In case of variation in the value of work by (minus) – fifty-five percent (55 %), the payment for (45-20) percent i.e., twenty-five percent (25 %) of the value of work shall be increased by eight percent (8 %).

A=Award Value (AV) =2013935.35

B=Executed Value (EV) =1164731.44

C=Decrease in value of work (B-A) = 849,203.91

D=% decrease in value of work (C/A%) = -42.17 %

E=% increase in the payment on plus a variation of -42.17 % based on variation slab=8 %

F=Amount on which an 8 % increase in payment will be applied (42.17- 20) %
*A=446,489.47

G=Decrease in payment (E %*F) =35,719.16

Final payable=B+G=12, 00,450.60

- 12.4.3. The Contractor within fifteen (15) days from the receipt of an order to execute any extra item shall submit rate analysis to the Project Manager supported by documentary evidence of basic rates adopted therein; having regard to the cost of materials, actual wages of labour, and other operational costs. The analysis provided by the Contractor shall form the basis for the determination of rates for such extra items. Extra items of work that are not provided in the Bill of Quantities shall be paid based on the Bhutan Schedule of Rates (BSR) after adjusting such rates for the place of Works and period elapsed after the date of BSR. If rates for such extra items are not

available in BSR, the rates for such items shall be determined based on the actual expenditure relating to that item including the cost of materials, fabrication/machinery handling, and erection at the site plus twenty percent (20 %) towards overheads including profits. The price of varied items determined by the Project Manager shall be final and binding on the Contractor. No payment shall be made for the items of Works ordered to be omitted.

- 12.4.4. If there is a delay in the Employer and the Contractor agreeing on the rate of varied work, provisional rates at the rate of seventy-five percent (75 %) of the rates as determined by the Employer shall be payable till the rates are finally determined. In any case, the Employer shall decide the rates within a maximum period of forty-five (45) days from the date of submission for the analysis of rates by the Contractor.
- 12.4.5. Items of work for which rates have been derived shall be eligible for price adjustment as per the price adjustment formula with base date as per the Contract. Rates for extra items, derived as per GCC.0 above, shall be eligible for price adjustment as per the price adjustment formula with the base date corresponding to the date of input costs considered for working out the rates.

12.5. Day Work

- 12.5.1. For work of a minor or incidental nature not covered in the Bill of Quantities, the Project Manager may instruct that a Change shall be executed on a day-work basis.
- 12.5.2. The Contractor shall deliver each day to the Project Manager accurate statements in duplicate which shall include the following details of the resources used in executing the previous day's work:
- a) the names, occupations, and time of the Contractor's employees;
 - b) the identification, type, and time of Contractor's Equipment and temporary works; and
 - c) the quantities and types of plants and materials used.
- 12.5.3. One copy of each statement shall, if correct, or when agreed, be signed by the Project Manager and returned to the Contractor. The Contractor shall then submit priced statements of these resources to the Project Manager for further approval and inclusion in the next running bill for payment.

12.6. Record of costs



- 12.6.1. In any case where the Contractor is instructed to proceed with a variation prior to the determination of the adjustment to the Contract Price in respect thereof, the Contractor shall keep records of the cost of undertaking the variation and of time expended thereon. Such records shall be open to inspection by the Project Manager at all reasonable times.

12.7. Change in Laws and Regulations

- 12.7.1. If, after the date seven (7) days prior to the last date of Bid submission, any law, regulation, ordinance, order or by-law having the force of law is enacted, promulgated, abrogated or changed in the Kingdom of Bhutan (which shall be deemed to include any change in interpretation or application by the competent authorities) that subsequently affects the costs and expenses of the Contractor and/or the Time for Completion, the Contract Price shall be correspondingly increased or decreased, and/or the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been affected in the performance of any of its obligations under the Contract. However, these adjustments would be restricted to direct transactions between the Employer and the Contractor. These adjustments shall not apply to the procurement of raw materials, intermediary components, etc. by the Contractor of a foreign Contractor and shall also not apply to the bought-out items dispatched directly from the sub-vendor's works to the site. Notwithstanding the foregoing, such additional or reduced costs shall not be separately paid or credited if the same has already been accounted for in the price adjustment provisions where applicable, in accordance with clause GCC 12.2 hereunder.

13. Contract Price and Payment

13.1. Contract Price

- 13.1.1. The Contract Price shall be as specified in the Contract Agreement subject to any additions and adjustments thereto or deductions therefrom as may be made pursuant to the Contract. If specified in the SCC, the Contract Price shall be adjusted.
- 13.1.2. The Contract Price charged by the Contractor for the performance of the Works shall not vary from the prices quoted by the Contractor in its Bid, with the exception of any price adjustments as per the provisions of the Contract specified in the SCC.
- 13.1.3. Subject to 2.3.12.3.1 and GCC16.1(h) hereof, the Contractor shall be deemed to have satisfied itself as to the correctness and sufficiency of the Contract Price, which shall, except as otherwise provided for in the Contract, cover all its obligations under the Contract.

13.2. Advance Payment

- 13.2.1. Mobilization Advance



- a) Employer may provide for payment of interest-free mobilization advance of a maximum of ten (10) percent of the Contract price on request from the Contractor if the payment of mobilization advance is stated in the SCC.
- b) Together with the request for mobilization advance, the Contractor shall submit an unconditional bank guarantee for an equivalent amount of advance requested in accordance with the Contract agreement.
- c) The advance shall be recovered through proportionate/percentage deductions from payments made to the Contractor. All advances shall be fully recovered by the time eighty percent (80 %) of the Contract is executed.

13.2.2. Secured Advance

- a) If stated in the SCC, the Employer may provide for payment of secured advance to the Contractor against the construction materials brought to the work site as per the Contract agreement and verified by the Project Manager. The list of materials and the quantities not liable for secured advance if any, shall be specified in the SCC. In exceptional circumstances, if specified in SCC, secured advance shall be given on account of plants & machinery.
- b) The payment of the secured advance shall be based on the following conditions:
 - a. The materials shall be in accordance with the specifications and shall not be more than the requirements;
 - b. A declaration shall be given by the Contractor passing on the lien on the rights of the materials to the Employer. However, the materials delivered at the work site shall be properly stored and protected against loss, damage, or deterioration by the Contractor;
 - c. The amount of the secured advance shall not be more than seventy-five (75 %) of the cost of materials delivered at the site of works, which shall be supported by the original invoices/bills. All materials imported from other countries shall be supported by Bhutan Sales Tax receipts or customs clearance. In case of fabrication works off-site, the secured advance may be paid to the Contractor after site inspection is carried out by the Procuring Agency at the cost of the Contractor, submission of proof of payment, and submission of work order;
 - d. The advance shall be recovered through proportionate/percentage deductions from payments made to the Contractor. All advances shall be fully recovered by the time eighty percent (80 %) of the Contract is executed.



13.3. Terms of Payment

13.3.1. The Contract Price shall be paid as specified in the Contract:

- a) The Contractor's request for payment shall be made to the Employer in writing accompanied by invoices and documents, describing, as appropriate, the work done and related services performed in fulfillment of the obligations stipulated in the Contract.
- b) Payment shall be made promptly by Employer, no later than 30 (thirty) days after the receipt of bills and documents in accordance with GCC 13.3.1(a), provided that the documents are compliant with all the requirements of Employer.
- c) No payment made by Employer herein shall be deemed to constitute acceptance by Employer of the works or any part(s) thereof.
- d) The currency or currencies in which payments are made to the Contractor under this Contract shall be those in which the Contract Price is expressed in the Contractor's Bid. In cases where the Bid price is in Indian Rupees or Bhutanese Ngultrum, the Employer shall at its discretion make payment in either of the currencies at the exchange rate of one Ngultrum = one Indian Rupee.
- e) Wherever applicable, the release of the first progressive interim payment shall be subject to submission of documentary evidence by the Contractor towards having taken the insurance policy (ies) and acceptance of the same by the Project Manager.

13.4. Taxes and Duties

13.4.1. The prices bid by the Contractor shall include all duties, taxes, and levies that may be levied in accordance with the laws and regulations in force as of the date 30 days prior to the closing date for submission of Bids. As such, except as otherwise specifically provided in the Contract, the Contractor shall bear and pay all taxes, duties, levies, and charges assessed on the Contractor, its subcontractors, or their employees by all municipal, state, or national government authorities in connection with the Works in and outside of the Kingdom of Bhutan.

13.4.2. At the time of the release of payment, tax shall be deducted at source (TDS) from Bhutanese Bidders and International Bidders as specified in the SCC from the gross amount of bills. An employer shall furnish the necessary TDS Certificate to the Bidders, issued by the Department of Revenue & Customs, RGoB. The Contractor shall be responsible for deducting tax at source from the gross payments made to the sub-contractors and deposit the same to the account of RGoB as per provisions of law in this regard in force from time to time.



- 13.4.3. If any rates of taxes or levies are increased or decreased, a new tax or levy is introduced, an existing tax is abolished, or any change in interpretation or application of any tax occurs in the course of the performance of Contract, an equitable adjustment of the Contract Price shall be made to fully take into account any such change by addition to the Contract Price or deduction therefrom, as the case may be.
- 13.4.4. The Contractor's staff, personnel, and labour shall be liable to pay personal income tax in Bhutan in respect of such of their salaries and wages as are chargeable under the laws and regulations in force and the Contractor shall perform such duties with regard to such deductions thereof as may be imposed on him by such laws and regulations.

13.5. Retention Money

- 13.5.1. The Employer shall retain ten percent (10 %) from each payment due to the Contractor in the proportion stated in the SCC until Completion of the whole of the Works as retention money.
- 13.5.2. The Retention Money may be returned to the Contractor upon issuance of a No Defects Liability Certificate. After completion of the work, the Contractor may substitute the retention money with an unconditional bank guarantee, issued/enforceable by any financial institution in Bhutan. Such bank guarantee shall be valid until the completion of the Defect Liability Period.
- 13.5.3. If the Contractor fails to remedy any reported defect within the Defects Liability Period, Employer shall withhold the payment or realize claims from the Retention Money, of an amount, which in the opinion of Employer, represents the cost of the defects to be remedied.
- 13.5.4. On completion of the Defects Liability Period, the Project Manager shall issue a no Defect Liability Certificate to the Contractor and release the retention money and/ or bank guarantee as available within fifteen (15) days from the issue of such certificate.

14. Termination

14.1. Termination for Employer's Convenience

- 14.1.1. An employer shall at any time terminate the Contract for any reason by giving the Contractor (and a copy to the Project Manager) a sixty (60) days prior notice of termination that refers to this clause GCC 14.1.

14.2. Termination for Contractor's default

- 14.2.1. In situations/conditions defined below, the Employer shall serve a notice to the Contractor highlighting the default/limitation on the part of the Contractor and advising the Contractor to

take appropriate corrective/remedial measures. If the Contractor fails to correct or to take steps to remedy the faults/limitations within fourteen (14) days of the notice served by Employer, Employer may, without prejudice to any other rights it may possess, terminate the Contract forthwith by giving a fifteen (15) days prior notice of termination with a copy to the Project Manager and its reasons thereof to the Contractor, referring to this clause GCC 14.2.1.

- a) If the Contractor becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, if the Contractor is a corporation, a resolution is passed or an order is made for its winding up (other than a voluntary liquidation for amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if the Contractor takes or suffers any other analogous action in consequence of debt;
- b) If the Contractor assigns or transfers or sub-Contracts the Contract in whole or in part or any right or interest therein in violation of the provision of 1.51.5.1;
- c) If the Contractor, in the judgment of Employer has engaged in fraud or corruption, as defined in 1.31.6 in competing for or in executing the Contract;
- d) If the Contractor has abandoned or repudiated the Contract for more than 30 days;
- e) If the Contractor has, without valid reasons, failed to commence the Works promptly or has suspended (other than pursuant to 14.5.4/14.5.4) the progress of Contract performance for more than twenty-eight (28) days after receiving a written instruction from Employer to proceed;
- f) If the Contractor persistently fails to execute the Contract in accordance with the Contract or persistently neglects to carry out its obligations under the Contract without just cause and does not make good such failure or neglect within a reasonable period even after written notice by the Project Manager;
- g) If the Contractor refuses or is unable to provide required/sufficient materials, services, equipment, or manpower to execute and complete the Works in the manner specified in the program furnished under 3.143.14.1 at rates of progress that give reasonable assurance to the Employer that the Contractor can attain completion of the Works by the Time for Completion as extended;
- h) If the liquidated damages to be levied in terms of the provisions under GCC 8.4.1 has reached a maximum of ten percent (10 %) of the Contract Price and it appears to the Project Manager that the Contractor is unable to complete the Works.

14.2.2. Upon receipt of the notice of termination under GCC 14.1 and GCC 14.2, the Contractor shall, either immediately or upon such date as is specified in the notice of termination:



- a) Cease all further work, except for such work as Employer may specify in the notice of termination for the sole purpose of protecting that part of the Works already executed, or any work required to leave the Site in a clean and safe condition;
 - b) Terminate all subcontracts, except those to be assigned to Employer pursuant to paragraph (d)(ii) below;
 - c) Remove all Contractor's Equipment from the Site, repatriate the Contractor's and its subcontractors' personnel from the Site, remove from the Site any wreckage, rubbish, and debris of any kind, and leave the whole of the Site in a clean and safe condition;
 - d) In addition, the Contractor, subject to the payment specified in GCC.14.4, shall:
 - (i) Deliver to Employer the parts of the Works executed by the Contractor up to the date of termination;
 - (ii) To the extent legally possible, assign to Employer all rights, title, and benefit of the Contractor to the Works and the plant, equipment, or material as at the date of termination, and, as may be required by Employer, in any subcontracts concluded between the Contractor and its subcontractors;
 - (iii) Deliver to Employer all non-proprietary drawings, specifications, and other documents prepared by the Contractor or its subcontractors as at the date of termination in connection with the Works.
- 14.2.3. Upon termination under GCC 14.2, the Employer may expel the Contractor, and complete the Works itself or by employing any third party. Employer may, to the exclusion of any right of the Contractor over the same, take over and use any Contractor's equipment owned by the Contractor and at site in connection with the Works for such reasonable period, as Employer considers expedient for the completion of the work. However, in doing so, the Employer shall pay a fair rental rate to the Contractor, bear all the maintenance costs, and indemnify the Contractor for all liability including damage or injury to persons arising out of the Employer's use of such equipment. Upon completion of the Works or at such earlier date as the Employer thinks appropriate, the Employer shall give notice to the Contractor that such Contractor's Equipment shall be returned to the Contractor at or near the Site and shall return such Contractor's Equipment to the Contractor in accordance with such notice. The Contractor shall thereafter without delay and at its cost remove or arrange removal of the same from the Site.

14.3. Termination by Contractor

- 14.3.1. The Contractor may terminate the Contract forthwith by giving notice to Employer to that effect, referring to this clause 14.3.1, if Employer becomes bankrupt or insolvent, has a receiving order



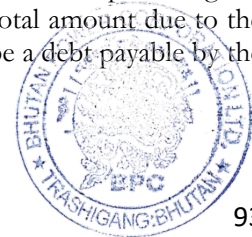
issued against it, compounds with its creditors, or, being a corporation, if a resolution is passed or order is made for its winding up (other than a voluntary liquidation for amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if Employer takes or suffers any other analogous action in consequence of debt.

14.3.2. If the Contract is terminated under 14.3.1, then the Contractor shall immediately:

- a) Cease all further work, except for such work as may be necessary for protecting that part of the Works already executed, or any work required to leave the Site in a clean and safe condition;
- b) Terminate all subcontracts, except those to be assigned to Employer pursuant to paragraph (d)(ii) below;
- c) Remove all Contractor's Equipment from the Site and repatriate the Contractor's and its subcontractor's personnel from the Site;
- d) In addition, the Contractor, subject to the payment specified in GCC 14.4, shall
 - (i) Deliver to Employer the parts of the Works executed by the Contractor up to the date of termination;
 - (ii) To the extent legally possible, assign to Employer all rights, titles and benefits of the Contractor to the Works and the plant, equipment, or materials as of the date of termination, and, as may be required by Employer, in any subcontracts concluded between the Contractor and its subcontractors;
 - (iii) Deliver to Employer all non-proprietary drawings, specifications, and other documents prepared by the Contractor or its subcontractors as of the date of termination in connection with the Works.

14.4. Payment upon Termination

14.4.1. If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Project Manager shall issue a certificate for the value of the work done and Materials ordered fewer advance payments received up to the date of the issue of the certificate and less the percentage to apply to the value of work not completed, as indicated in the SCC. If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable by the Contractor to the Employer.



- 14.4.2. If the Contract is terminated for the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Project Manager shall issue a certificate for the value of the work done, Materials ordered, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works, and less advance payments received up to the date of the certificate.

14.5. Suspension

- 14.5.1. Employer /Project Manager may, by notice to the Contractor, order the Contractor to suspend the performance of any or all of its obligations under the Contract. Such notice shall specify the obligation of which performance is to be suspended, the effective date of the suspension, and the reasons thereof. The Contractor shall thereupon suspend the performance of such obligation (except those obligations necessary for the care or preservation of the Works) until ordered in writing to resume such performance by the Project Manager/ Employer.
- 14.5.2. If, by virtue of a suspension order given by the Project Manager/ Employer, the Contractor's performance of any of its obligations is suspended for an aggregate period of more than ninety (90) days, then at any time thereafter and provided that at that time such performance is still suspended, the Contractor may give notice to the Project Manager requiring that Employer shall, within twenty-eight (28) days of receipt of the notice, order the resumption of such performance or request and subsequently order a Change in the Works in accordance with GCC 12.2, excluding the performance of the suspended obligations from the Contract.
- 14.5.3. If the Employer fails to do so within such period, the Contractor may, by further notice to the Project Manager, elect to treat the suspension, where it affects only a part of the Works, as deletion of such part of the Works in accordance with GCC 12.2 or, where it affects the whole of the Works, as termination of the Contract under 14.1.
- 14.5.4. Under the condition (a) and (b) below, the Contractor may, by giving fourteen (14) days' notices to the Employer suspend the performance of all or any of its obligations under the Contract, or reduce the rate of progress:
- a) If Employer has failed to pay the Contractor any sum due under the Contract within the specified period or has failed to approve any invoice or supporting documents without just cause or commits a substantial breach of the Contract, the Contractor may give a notice to Employer that requires payment of such sum, requires approval of such invoice or supporting documents, or specifies the breach and requires Employer to remedy the same, as the case may be. If Employer fails to pay such sum, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, or fails to remedy the breach or take steps to remedy the breach within fourteen (14) days after receipt of the Contractor's notice; or
 - b) If the Contractor is unable to carry out any of its obligations under the Contract for any reason attributable to Employer, including but not limited to Employer's failure to provide

possession of or access to the Site or other areas in accordance with 2.3.2, or failure to obtain any governmental permit necessary for the execution and/or completion of the Works;

- 14.5.5. If the Contractor's performance of its obligations is suspended or the rate of progress is reduced pursuant to this clause GCC 14.5, then the Time for Completion shall be extended in accordance with GCC 8.3.1, and any and all additional costs or expenses incurred by the Contractor as a result of such suspension or reduction shall be paid by Employer to the Contractor in addition to the Contract Price, except in the case of suspension order or reduction in the rate of progress by reason of the Contractor's default or breach of the Contract.
- 14.5.6. During the period of suspension, the Contractor shall not remove from the Site any plant, equipment, material or any part of the Works or any Contractor's Equipment, without the prior written consent of Employer.

15. Care of the Works and Indemnities

15.1. Protection of Works

- 15.1.1. The Contractor shall have total responsibility for protecting the Works till it is finally taken over by the Employer. No claim shall be entertained by the Employer for any damage or loss to the Works and the Contractor shall be responsible for the complete restoration of the damaged works/equipment to its original condition to comply with the specification and drawings.
- 15.1.2. The Contractor shall, in connection with the Works, provide and maintain at his own cost all lights, guards, fencing, and security when and where necessary or required by the Employer or by any authority for the protection of the Works or the safety and convenience of the public or others.

15.2. Copyright

- 15.2.1. The copyright of all drawings, documents, and other materials containing data and information furnished to Employer by the Contractor shall remain vested in the Contractor, or, if they are furnished to Employer directly or through the Contractor by any third party, including suppliers of materials, the copyright in such materials shall remain vested in such third Party.

15.3. Confidential Information

- 15.3.1. Employer and the Contractor shall keep confidential and shall not, without the written consent of the other Party hereto, divulge to any third party any documents, data, or other information furnished directly or indirectly by the other Party hereto in connection with the Contract, whether such information has been furnished prior to, during or following completion or termination of the Contract. Notwithstanding the above, the Contractor may furnish to its Sub-vendors such

documents, data, and other information as it receives from the Employer to the extent required for the Sub-vendors to perform its obligations under the Contract, in which event the Contractor shall be under obligation to have a clause in the Contracts with their sub-vendors regarding confidentiality similar to that provided herein.

- 15.3.2. Employer shall not use such documents, data, and other information received from the Contractor for any purposes unrelated to the Contract. Similarly, the Contractor shall not use such documents, data, and other information received from the Employer for any purpose other than the design, procurement of plant and equipment, construction, or such other work and services as are required for the performance of the Contract.
- 15.3.3. The obligation of a Party under 15.3.1 and 15.3.2 above, however, shall not apply to information that:
- a) Employer or the Contractor needs to share with the RGoB;
 - b) Is already in the public domain now, or enters the public domain during the execution of the Contract through no fault of that Party;
 - c) Can be proven to have been possessed by that Party at the time of disclosure and which was not previously obtained, directly or indirectly, from the other Party; or
 - d) Otherwise lawfully becomes available to that Party from a third party that has no obligation of confidentiality.
- 15.3.4. The above provisions of GCC 15.3 shall not in any way modify any undertaking of confidentiality given by either of the Parties hereto prior to the date of the Contract in respect of the performance of the Contract or any part thereof.
- 15.3.5. The provisions of GCC 15.3 shall survive completion or termination, for whatever reason, of the Contract.

15.4. Patent Indemnity

- 15.4.1. The Contractor shall, subject to Employer's compliance with 15.4.2, indemnify and hold harmless Employer and its employees from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of any nature, including attorney's fees and expenses, which Employer 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 Contract because of



- a) The execution of the Works by the Contractor or the use of the Works in the Kingdom of Bhutan; and
 - b) The sale in any country of the products produced by the Works.
- 15.4.2. Such indemnity shall not cover any use of the Works or any part thereof other than for the purpose indicated by or reasonably to be inferred from the Contract, neither any infringement resulting from the use of the Works or any part thereof, nor any products produced thereby in association or combination with any other equipment, plant or materials not supplied by the Contractor, pursuant to the Contract.
- 15.4.3. If any proceedings are brought or any claim is made against Employer arising out of the matters referred to in 15.4.1, Employer shall promptly give the Contractor notice thereof, and the Contractor may at its own expense and in Employer's name conduct such proceedings or claims and any negotiations for the settlement of any such proceedings or claims.
- 15.4.4. If the Contractor fails to notify Employer within thirty (30) days after receipt of such notice that it intends to conduct any such proceedings or claims, then Employer shall be free to conduct the same on its own behalf at the cost of the Contractor.
- 15.4.5. Employer shall, at the Contractor's request, provide all available assistance to the Contractor in conducting such proceedings or claims, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.
- 15.4.6. An employer shall indemnify and hold harmless the Contractor and its employees from and against any and all suits, actions, or administrative proceedings, claims, demands, losses, damages, costs, and expenses of any nature, including attorney's fees and expenses, which the Contractor 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 Contract arising out of or in connection with any design, data, drawing, specification or other documents or materials provided or designed by or on behalf of Employer.

15.5. Limitations of Liability

- 15.5.1. In cases of gross negligence or willful misconduct:
- a) Neither Party shall be liable to the other Party, whether in Contract, tort, or otherwise, for any indirect or consequential loss, damage, loss of use, loss of production, or loss of profits or interest costs. However, this exclusion shall not apply to any obligation of the Contractor to pay liquidated damages to the Employer; and



- b) The aggregate liability of the Contractor to Employer, whether under the Contract, in tort or otherwise, shall not exceed the total Contract Price. However, this limitation shall not apply to the cost of repairing or repairing defective works, or to any obligation of the Contractor to indemnify the Employer with respect to patent infringement.

15.5.2. In all cases, the Party claiming a breach of Contract or a right to be indemnified in accordance with the Contract shall be obliged to take all reasonable measures to mitigate the loss or damage.

15.6. Indemnification Employer

15.6.1. The Contractor shall indemnify and hold harmless Employer and its employees 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, in respect of the death or injury of any person or loss of or damage to any property (other than the Works whether accepted or not), arising in connection with the execution of Works and caused due to the negligence of the Contractor or its subcontractors, or its employees, or agents. For any injury, death, or damages to property caused by the negligence of Employer, its other Contractors, employees, or agents Employer shall be responsible.

15.6.2. If any proceedings are brought or any claim is made against Employer that might subject the Contractor to liability under 15.6.1, Employer shall promptly give the Contractor a notice thereof and the Contractor shall at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

15.6.3. If the Contractor fails to notify Employer within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify Employer within the twenty-eight (28) day period, Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim.

15.6.4. Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.

15.6.5. Employer shall indemnify and hold harmless the Contractor and its employees and subcontractors from any liability for loss of or damage to property of Employer, other than the Works not yet taken over, that is caused by fire, explosion, or any other perils, in excess of the amount recoverable from insurances procured under GCC.17, provided that such fire, explosion or other perils were not caused by any act or failure of the Contractor.

15.6.6. The Party entitled to the benefit of an indemnity under this clause 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.



16. Exceptional Event (Force Majeure)

16.1. “Force Majeure” shall mean any unavoidable event beyond the reasonable control of the Employer or of the Contractor, as the case may be, and which has impeded the progress of work unreasonably and shall include, without limitation the following:

- a) War, hostilities or warlike operations whether a state of war be declared or not, invasion, an act of foreign enemy, and civil war;
- b) Rebellion, terrorism, revolution, sabotage by persons other than the Contractor’s personnel, insurrection, mutiny, usurpation of civil or military government, conspiracy, riot, civil commotion and terrorist acts;
- c) Riot, commotion, disorder, strike, or lockout by persons other than the Contractor’s personnel;
- d) Munitions of war, explosive materials, ionizing radiation or contamination by radio-activity, except as may be attributable to the Contractor’s use of such munitions, explosives, radiation, or radio-activity;
- e) Confiscation, nationalization, mobilization, commandeering, or requisition by or under the order of any government or de jure or de facto authority or ruler or any other act or failure to act of any government authority;
- f) Embargo, import restriction, port congestion, industrial dispute, shipwreck, shortage or restriction of power supply, epidemics/pandemic, quarantine and plague;
- g) Natural catastrophes such as earthquakes, hurricanes, typhoons, volcanic activity, fire, landslide or flood;
- h) The physical conditions or artificial obstructions on the Site.

16.2. If a force majeure situation arises, the Bidder shall notify the Employer in writing within seven (7) days of such conditions and the cause thereof along with documentary or pictorial evidence acceptable to the Employer. Unless otherwise directed by the Employer in writing, the Bidder shall continue to perform its obligation.

16.3. The Party who has given such notice shall be excused from the performance or punctual performance of its obligations under the Contract for so long as the relevant event of Force Majeure continues and to the extent that such Party’s performance is prevented, hindered, or delayed. The Time for Completion shall be extended in accordance with GCC 8.3.



- 16.4.** The Party or Parties affected by the event of Force Majeure shall use reasonable efforts to mitigate the effect thereof upon its or their performance of the Contract and to fulfill its or their obligations under the Contract so far as reasonably practicable.
- 16.5.** Delay or non-performance by either Party hereto caused by the occurrence of any event of Force Majeure after the Contract has become effective shall not:
- a) Constitute a default or breach of the Contract;
 - b) Give rise to any claim for damages or additional cost or expense occasioned thereby.
- 16.6.** If the performance of the Contract is substantially prevented, hindered, or delayed for a single period of more than sixty (60) days or an aggregate period of more than one hundred and twenty (120) days on account of one or more events of Force Majeure during the currency of the Contract, the Parties shall attempt to develop a mutually satisfactory solution, failing which the dispute shall be resolved in accordance with 2.
- 16.7.** Notwithstanding 16.5, Force Majeure shall not apply to any obligation of Employer to make payments to the Contractor herein.

17. Insurance

- 17.1.** The Contractor shall provide, in the joint names of the Employer and the Contractor, insurance cover from the date of commencement of the Works to the end of the respective periods specified below, in the amounts and deductibles stated in the SCC for the following events:

Sl. #	Nature of insurance	Period of insurance coverage
i	Loss of or damage to the Works including Employer issued materials, if any	Up to the date of Taking Over the last Works
ii	Loss of or damage to the Contractor's tools and plant	Up to the date of Taking Over the last Works

iii	Loss of or damage to the property other than Works including those of third parties	Up to the completion of the Defects Liability Period
iv	Injury or death of personnel belonging to the Contractor, Employer, or any other party	Up to the completion of the Defects Liability Period

The insurance policy for (iv) above shall be taken from Bhutanese insurance companies.

- 17.2.** Policies and certificates for insurance shall be delivered by the Contractor to the Project Manager for the Project Manager's approval before the start date. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred. Payments received from insurers shall be used for the rectification of loss or damage.
- 17.3.** If the Contractor does not provide any of the policies and certificates required, the Employer may affect the insurance which the Contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due from the Contractor to the Employer.
- 17.4.** Alterations to the terms of insurance shall not be made without the approval of the Project Manager. Both parties shall comply with any conditions of the insurance policies.

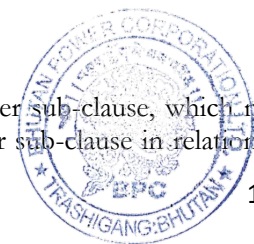
18. Claims

18.1. Contractor's Claims

- 18.1.1.** If the Contractor considers himself to be entitled to any extension of the Time for Completion and/or any additional payment, under any clause of GCC.18 or otherwise in connection with the Contract, the Contractor shall give notice to Employer, describing the event or circumstances giving rise to the claim. The notice shall be given as soon as practicable, and not later than thirty (30) days after the Contractor became aware, or should have become aware, of the event or circumstance.
- 18.1.2.** If the Contractor fails to give notice of a claim within such period of thirty (30) days, the Time for Completion shall not be extended, the Contractor shall not be entitled to additional payment, and the Employer shall be discharged from all liability in connection with the claim. Otherwise, the following provisions of this sub-clause shall apply.
- 18.1.3.** The Contractor shall also submit any other notices which are required by the Contract, and supporting particulars for the claim, as relevant to such event or Circumstances.



- 18.1.4. The Contractor shall keep such contemporary records as may be necessary to substantiate any claim, either on the Site or at another location acceptable to the Project Manager. Without admitting the Employer's liability, the Project Manager may, after receiving any notice under this sub-clause, monitor the record-keeping and/or instruct the Contractor to keep further contemporary records. The Contractor shall permit the Project Manager to inspect all these records, and shall (if instructed) submit copies to the Project Manager.
- 18.1.5. Within forty-two (42) days after the Contractor became aware (or should have become aware) of the event or circumstances giving rise to the claim, or within such other period as may be proposed by the Contractor and approved by the Project Manager, the Contractor shall send to the Project Manager a fully detailed claim which includes full supporting particulars of the basis of the claim and for the extension of time and/or additional payment claimed. If the event or circumstance giving rise to the claim has a continuing effect:
- a) this fully detailed claim shall be considered interim;
 - b) the Contractor shall send further interim claims at monthly intervals, giving the accumulated delay and/or amount claimed, and such further particulars as the Project Manager may reasonably require; and
 - c) the Contractor shall send a final claim thirty (30) days after the end of the effects resulting from the event or circumstances, or within such other period as may be proposed by the Contractor and approved by the Project Manager.
- 18.1.6. Within forty-two (42) days after receiving a claim or any further particulars supporting a previous claim, or within such other period as may be proposed by the Project Manager and approved by the Contractor, the Project Manager shall respond with approval, or with disapproval and detailed comments. He may also request any necessary further particulars, but shall nevertheless give his response on the principals of the claim within such time.
- 18.1.7. Each payment certificate shall include such amounts for any claim as have been reasonably substantiated as due under the relevant provision of the Contract. Unless and until the particulars supplied are sufficient to substantiate the whole of the claim, the Contractor shall only be entitled to payment for such part of the claims, as he has been able to substantiate.
- 18.1.8. The Project Manager shall proceed to determine (i) the extension (if any) of the Time for Completion (before or after its expiry), and/or (ii) the additional payment (if any) to which the Contractor is entitled under the Contract.
- 18.1.9. The requirements of this sub-clause are in addition to those of any other sub-clause, which may apply to a claim. If the Contractor fails to comply with this or any other sub-clause in relation to



any claim, any extension of time and/or additional payment shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the claim, unless the claim is excluded under the second paragraph of this sub-clause.

18.2. Claims towards idling of resources

18.2.1. Components of claim admissible hereunder towards the additional cost incurred by the Contractor due to the idling of resources in connection with the execution of the Contract for reasons given hereunder shall be evaluated by the Project Manager:

- a) An employer does not give possession to the Site or a part of the Site free of all encumbrances by the Site possession date stated in the SCC;
- b) Employer modifies the schedule of other Contractors in a way that affects the works of the Contractor under the Contract;
- c) Employer's representatives do not issue Drawings, Technical Specifications, or instructions required for the execution of Works as per the agreed schedule;
- d) Other Contractors or Employer does not work within the dates stated in the Contract that cause delay or extra work to the Contractor.

18.2.2. The evaluation of compensation towards the idling of resources done by the Project Manager shall be final and binding on the Contractor. The procedure as provided in GCC.17.1 for settlement of claims shall also apply to such claims.

18.3. Early Warning

18.3.1. The Contractor shall warn the Project Manager in writing at the earliest of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price, or delay the execution of the Works. The Project Manager may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate shall be provided by the Contractor not later than 30 days after the Contractor became aware, or should have become aware, of the event or circumstance. If the Contractor fails to give notice of a claim within such period of 30 days, the Employer may be discharged from all liability in connection with the claim.

19. Disputes and Arbitrations

19.1. Amicable Settlement



- 19.1.1. If any dispute of any kind whatsoever arises between Employer and the Contractor in connection with or arising out of the Contract, including without prejudice to the generality of the foregoing, any question regarding its existence, validity or termination, or the execution of the works – whether during the progress of the works or after their completion and whether before or after the termination, abandonment or breach of the Contract – the parties shall seek to resolve any such dispute or difference by mutual consultation.

19.2. Dispute Resolution

- 19.2.1. In case of dispute, the objecting party may file a written Notice of dispute to the other Party providing in detail the basis of the dispute. The Party receiving the Notice of Dispute shall consider it and respond in writing within 14 days after receipt. If that Party fails to respond within 14 days, or the dispute cannot be amicably settled within 14 days following the response of that Party, clause GCC.19.2.2 shall apply.
- 19.2.2. Any dispute between the Parties as to matters arising pursuant to this Contract that cannot be settled amicably according to clauses GCC.19.2.1 and GCC.19.2.2 may be submitted by either Party for settlement in accordance with the provisions specified in the SCC.
- 19.2.3. Notwithstanding any reference to the settlement of the dispute settlement herein:
- a) The Parties shall continue to perform their respective obligations under the Contract unless they otherwise agree; and
 - b) An employer shall pay the Contractor any monies due to it.



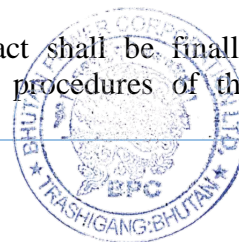
SECTION V – SPECIAL CONDITIONS OF CONTRACT

Special Conditions of Contract

The following Special Conditions of Contract (SCC) shall supplement and/or amend the General Conditions of Contract (GCC). Whenever there is a conflict, the provisions herein shall prevail over those in the GCC.

GCC Clause Ref., if any	Particulars						
1.1.1 (xxvii)	The Project Manager shall be: <i>Chief Divisional Manager, Electricity Services Division, DD, BPC, Trashigang.</i>						
1.1.1 (xxix)	The Site is located at <i>Yabrang-Janjanma, Phugayee-Walkhar, and Gomchu.</i>						
1.1.1 (xxxi)	Completion of Works shall be attained as shown in the table below from the Date of Site Handing Taking. <table><tr><th>Sl. No</th><th>Dzongkhags</th><th>Contract Duration (months)</th></tr><tr><td>1</td><td>Trashigang</td><td>5</td></tr></table>	Sl. No	Dzongkhags	Contract Duration (months)	1	Trashigang	5
Sl. No	Dzongkhags	Contract Duration (months)					
1	Trashigang	5					
1.2.6 (a)	The applicable Incoterms edition shall be of <i>Not applicable</i>						
1.3.2	For notices, the addresses shall be: For the Employer: Attention: <i>Chief Divisional Manager, Electricity Services Division, DD, BPC, Trashigang.</i>						
2.3.4	The list of manpower, equipment, raw material, etc. to be provided by the Employer: <i>Not applicable</i>						
3.2.1 3.2.3	The amount of the Performance Security shall be <i>10 % of the contract price.</i> The types of acceptable Performance Securities are: <i>(i) Unconditional bank guarantee issued by a reputable financial institution enforceable in any banks in Bhutan, in the form provided for in the Contract or any other form acceptable or;</i> <i>(ii) Cash warrant/Banker's Cheque or;</i> <i>(iii) Demand Draft</i> <i>In favour of the Chief Divisional Manager, Electricity Services Division, BPC, Trashigang</i>						
3.2.2	For Contracts not deducting retention money, the Contractor shall extend the validity of the performance security until 30 days beyond the defect liability period (DLP) before the release of the final bill payment. <i>Not Applicable</i>						
3.12.1	The temporary utilities to be provided by the Employer are: <i>Not applicable</i>						
5.1.1	Key Personnel: <i>Not Applicable</i>						

8.4.1	The applicable rate for liquidated damages for delay shall be		
	Sl. No	Dzongkhags	LD (%) applicable <i>per day</i>
	1	Trashigang	0.1
	The maximum number of liquidated damages shall be 10 % of the contract price.		
9.2.7	The permanent information board: Not applicable		
10.1.1 10.3.2	The Defect Liability Period shall be 12 Months from the date of taking over.		
12.1.2	Contract Price Adjustment: Not applicable		
13.1.1	The Contract Price “is not” adjustable.		
13.2.1 (a)	The Mobilization Advance Payment shall be a maximum of ten percent (10 %) of the Contract Price against the submission of an unconditional bank guarantee issued by a reputable financial institution and enforceable by any Bank in Bhutan.		
13.2.2 (a)	The secured advance shall not be applicable.		
13.4.2	The present rate of tax deducted at source (TDS) of the gross value of the invoice is 2 %.		
17.1	The nature and content, amounts, and deductibles on insurance shall be as follows:		
	SN	Insurance	Amount Insured
	1	Loss of or damage to the Works including Employer issued materials, if any	110 % of the cost of Works
	2	Loss of or damage to the Contractor's tools and plant	110 % of the cost of tools and plant
	3	Loss of or damage to the property other than Works including those of third parties	As permissible under the policy
	4	Injury or death of personnel belonging to the Contractor, Employer, or any other party	As permissible under the policy
19.2.2	Institution whose arbitration procedures shall be used:		
	<u>For Contracts with Bhutanese Contractors</u>		
	All disputes arising in connection with the present Contract shall be finally resolved by arbitration in accordance with the rules and procedures of the Alternate Dispute Resolution Act 2013.		



SECTION VI – TECHNICAL SPECIFICATIONS

BHUTAN POWER CORPORATION LIMITED



DISTRIBUTION DESIGN AND CONSTRUCTION STANDARDS (DDCS)



Third Edition (Amendment) 2023

FOREWORD

Bhutan Power Corporation Limited would like to present the third edition of Distribution Design and Construction Standard (DDCS). The second edition was published in 2016. This document has been prepared by Engineering & Research Department (E&RD) as a guide to BPC engineers and supervisors in the field to adopt uniform technical specifications and standards. DDCS was finalized by E&RD by collecting feedback from site officials, conducting consultations and discussions with relevant departments.

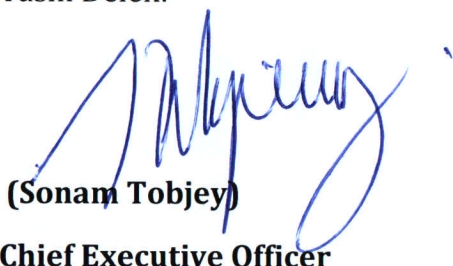
The document has been reviewed in both electrical and civil aspects. Foundation design for transformers, Ring Main Unit and Unitized Substation are added to the standard. The electrical parameters of the equipment are updated as per the latest standard. The construction standard provides minimum standards on methods of construction, repair or other improvements as and when required. These standard construction specifications shall apply to all materials and methods of construction for the work performed either departmentally by BPC or by contractors.

The DDCS provides a single document for:

- Standardising Distribution Design and Construction practices to the extent that is economical, practical and efficient,
- Promoting design and installation practices that minimize electrical hazards and follow good international practices in Distribution Engineering,
- Reducing unnecessary desktop works for the field units and maintaining quality site works,
- Maintaining standardized BOQ of materials, and
- Assisting in optimizing material procurement and inventory.

DDCS will be revised periodically and amendments will be issued if required to incorporate any new advancements in the technology and construction methodology.

Tashi Delek!


(Sonam Tobjey)
Chief Executive Officer

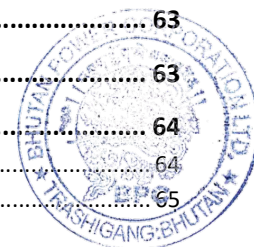


1. Table of Contents

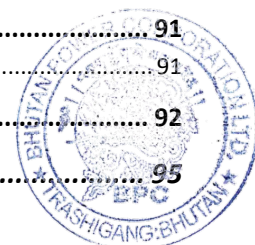
INTRODUCTION	9
OVERVIEW OF ELECTRICITY DISTRIBUTION IN BHUTAN	10
1. DESIGN PARAMETERS.....	11
1.1 Local Conditions	11
1.2 Electrical Design Parameters.....	11
1.2.1 De-rating	12
1.2.2 Basic Insulation Level (BIL) De-rating According to Altitude.....	13
1.2.3 Electrical Clearance According to Altitude	13
1.3 Mechanical Design Parameters	13
1.3.1 Overhead Line Clearances	14
1.4 Underground System	15
1.4.1 Direct Burial Method.....	15
1.4.2 Trench method	15
1.4.3 Conduit Method	16
1.4.4 Spacing between Cables.....	16
1.4.5 De-rating (Correction Factors) of Cables.....	16
2. MEDIUM VOLTAGE SYSTEM.....	17
2.1 Phase Relationships.....	17
2.2 Power Transformers.....	17
2.2.1 Fittings and Accessories	19
2.2.2 Voltage Control of Power Transformers.....	20
2.2.3 OLTC Cabinet	20
2.2.4 Remote Tap Changer Control Panel.....	21
2.2.5 OLTC Control Scheme	22
2.2.6 Auxiliary Power Supply for OLTC	23
2.2.7 Protection of Power Transformers	23
2.3 MV Switchgears.....	24
2.3.1 Compulsory rated characteristics of Switchgear	24
2.3.2 Circuit Breakers.....	26
2.3.3 Current Transformer.....	28
2.3.4 Potential Transformer	29
2.3.5 Energy Metering.....	29
2.3.6 General Requirement of Protection Relays	30
2.4 Gas Insulated Switchgear	32
2.5 Control and Interlocking Schemes for MV Switchgear	32
2.5.1 Voltage Selection Scheme For Two Incomers	32
2.5.2 Synchronizing Schemes	33
3. DISTRIBUTION SYSTEM DESIGN.....	34
3.1 Distribution System Arrangements	34



3.1.1	Underground Systems.....	34
3.1.2	Overhead Distribution Systems	35
3.1.3	Mixed Distribution Systems.....	36
3,2	Voltage Drops.....	37
3.2.1	Maximum Length of MV Overhead Lines.....	37
3.2.2	Load Moments	40
3.2.3	Medium Voltage Underground Cables	43
3.2.4	Selection of Low Voltage Conductors	44
3.2.5	Overhead Service Lines	46
3.2.6	Underground Low Voltage Distribution Cables	48
3.2.7	Underground Service Line Cables	49
3.3	General Earthing Arrangement	50
3.4	Overhead Line Design	50
3.4.1	Medium Voltage Lines	50
3.4.2	Low Voltage ABC Lines	53
4.	STANDARDISATION OF DISTRIBUTION EQUIPMENT	55
4.1	Introduction	55
4.2	Poles	55
4.2.1	Steel Swaged Poles	55
4.2.2	Galvanised Telescopic Pole	55
4.2.3	Base Plate, Pole Cap and Pole Earthing.....	57
4.2.4	Foot Bars and Installation Lugs.....	57
4.2.5	Anti-climbing Device	57
4.2.6	Danger Plate.....	58
4.3	Clamps.....	58
4.3.1	Clamps for Galvanised Telescopic Pole	58
4.3.2	Clamps for Steel Swaged Pole.....	59
4.4	Line Cross-arm Assemblies for Steel Swaged Pole	59
4.4.1	Single Pole Assemblies.....	59
4.4.2	Double Pole Assemblies	59
4.5	Line Cross-arm Assemblies for Telescopic Pole (11.2 meter)	60
4.5.1	Single Pole Assemblies	60
4.5.2	Double Pole Assemblies	61
4.6	Line Cross-arm Assemblies for Telescopic Pole (12 meter)	61
4.6.1	Single Pole Assemblies.....	61
4.6.2	Double Pole Assemblies	62
4.7	Substation Structure Assemblies.....	63
4.8	Load Break Switch/Air Break Switch Assemblies	63
4.9	Auto Recloser Assemblies	63
4.10	Insulators	64
4.10.1	Pin Insulators.....	64
4.10.2	Fittings for Pin Insulators	65



4.10.3	Disc Insulator.....	66
4.10.4	Insulator Hardware Fittings.....	67
4.10.5	Stay Insulators.....	67
4.11	Earthing Equipments	68
4.11.1	Spike Earthing	68
4.11.2	Pipe Earthing	68
4.11.3	Stay Assembly.....	68
4.11.4	Stay Wire.....	69
4.11.5	GI Shielding Wire.....	69
4.11.6	Guard Wire.....	69
4.12	Overhead Line Conductors	69
4.12.1	Aluminium Conductor Steel Reinforced Conductor	70
4.12.2	All Aluminium Alloy Conductor Covered.....	70
4.12.3	High Voltage Aerial Bundle Conductor.....	71
4.12.4	Low Voltage Aerial Bundled Conductor	72
4.12.5	Low Voltage Overhead Service Cable	73
4.13	Underground Distribution Cable.....	74
4.13.1	33 kV and 11 kV Cable	74
4.13.1	400 V Cable	76
4.14	Distribution Transformers	77
4.14.1	Standard Fittings	78
4.14.2	Protection of Distribution Transformers	79
4.15	Unitized Substation/Compact Substation (USS/CSS).....	80
4.15.1	MV Switchgear/Ring Main Unit (RMU)	81
4.15.2	Transformer.....	83
4.15.3	LV Switchboard.....	83
4.15.4	Outdoor Enclosure	85
4.16	Low Voltage Distribution Boards	85
4.17	Surge Arrestors.....	86
4.17.1	Arrester Fittings	86
	meters	
4.18	Auto-reclosers.....	87
4.18.1	Situations where Auto-Reclosers may be used are:	87
4.19	Fault Passage Indicators	89
4.20	MV Drop-Out Fuses.....	89
4.20.1	Fuse link.....	90
4.20.2	D.O. Barrels (Carrier Tube).....	91
4.21	Medium Voltage Load Break Switches.....	91
4.21.1	Load Break Switch (LBS)/ Air Break Switch	91
4.22	Optical Fiber cable – ADSS.....	92
5.	CONSTRUCTION STANDARD.....	95



5.1 Overhead Lines.....	95
5.1.1 Choice of Route.....	95
5.1.2 Approval of Line Routes.....	96
5.1.3 Tree Clearances	96
5.2 Overhead Line Construction	97
5.2.1 Pit Making and Digging Procedure.....	97
5.2.2 Erection of Supports	97
5.2.3 Erection of Double Pole Structures for Angle Locations	98
5.2.4 Special Foundation	98
5.2.5 Anchoring and Providing Guys for Supports.....	98
5.2.6 Fixing of Cross Arms and Insulators	99
5.2.7 Erection of ACSR Conductor	100
5.2.8 Mid-Span Jointing of Conductors.....	100
5.2.9 Jumpering.....	100
5.2.10 Sagging and Tensioning of Conductors.....	100
5.2.11 Conductor Sag and Tension	102
5.2.12 Supports at Different Elevation	106
5.2.13 Good Conductor Stringing Work Practices.....	106
5.2.14 HV ABC Accessories	108
5.2.15 Low Voltage Aerial Bundled Cable	109
5.3 Special Crossings.....	110
5.4 Guarding	110
5.5 Pole Earthing	110
5.6 Final Completion and Commissioning of MV Lines	111
5.7 Installation of Distribution Transformer	111
5.7.1 Pole Mounted Transformers.....	111
5.7.2 Site Selection for Pole mounted Transformers	112
5.7.3 Pad Mounted Distribution Transformers	112
5.8 Substation Earthing	113
5.9 Transportation and Handling of Transformers.	113
5.10 Protection of Distribution Transformers	114
5.11 General Requirement of Distribution Boards.....	117
5.12 Connection of supply to consumer's premises	119
5.12.1 Consumer Metering	120
5.12.2 Direct Connected Metering.....	120
5.12.3 CT Metering	121
5.12.4 High Voltage Metering	121
5.13 Underground Cable Installation.....	121
5.13.1 General.....	121
5.13.2 Outdoor Cable Installation	122
5.13.3 Bending Radii for Cables	123
5.13.4 Terminations Clamping & Miscellaneous Details	123
5.13.5 Earthing of Cables	124



LIST OF TABLES

Table 1: General Local Condition ¹	11
Table 2: Minimum Insulation and Short Circuit Withstand Parameters – Medium Voltage	11
Table 3: Insulation Parameters – Low Voltage	12
Table 4: System Variation.....	12
Table 5: Minimum Air Clearances for Equipment Terminals	12
Table 6: Overhead Line Design Parameters	13
Table 7: Minimum Factor of Safety (FoS)	13
Table 8: Minimum Overhead Line Conductor Clearances	14
Table 9: Vertical Separation of Conductors of Different Voltages on Same Structure	14
Table 10: Depth of Direct Burial of Underground Cable with or without conduit	15
Table 11: Spacing of Underground Cables	16
Table 12: Standard Specifications for 33/11 kV Power Transformers.....	17
Table 13: Maximum allowable Losses at 75°C ¹	18
Table 14: Minimum General Technical Parameters of the MV Switchgears.....	25
Table 15: Selection of Circuit breakers.....	26
Table 16: Minimum General Specification for Medium Voltage Circuit Breakers	27
Table 17: General requirement of HT Energy Meters ¹	30
Table 18: Maximum Circuit Length of 33 kV Overhead Lines.....	38
Table 19: Maximum Circuit Length of 11 kV Overhead Lines.....	38
Table 20: Maximum Circuit Length of HV ABC cable for 11 kV	39
Table 21: Maximum Circuit Length of 33 kV AAAC Covered	39
Table 22: Maximum Circuit Length of 11 kV AAAC Covered	40
Table 23: Maximum Load Moments for Standard Overhead Conductors.....	41
Table 24: Calculation of Load Moments in Sample Feeder	41
Table 25: Calculation of Segment Voltage Drops	42
Table 26: Calculation of Voltage Drops at Load Points.....	42
Table 27: Medium Voltage Underground Circuit Lengths.....	43
Table 28: Use of Different Size 33 kV Cables	44
Table 29: Use of Different Size 11 kV Cables	44
Table 30: Maximum Length of Low Voltage Overhead Distribution Circuits 50mm ² ABC.....	45
Table 31: Maximum Length of LV Overhead Distribution Circuits 95 mm ² ABC	45
Table 32: Maximum Load Moments of Low Voltage Overhead Distribution Circuits.....	46
Table 33: Selection Guide for Single Phase Overhead Copper Service Line Cables	47
Table 34 : Selection Guide for Single Phase Overhead Aluminium Service Cables	47
Table 35 (a): Selection Guide for Three Phase Overhead copper Service Line Cables	47
Table 35 (b): Selection Guide for three Phase Overhead Aluminium Service Cables	48
Table 36: Design Data for Underground Low Voltage Distribution Cables	49
Table 37: Selection Guide for Underground Aluminium Service Line Cables	49
Table 38: Required Steel Swaged Pole Strength for MV Overhead Lines (ACSR)	51
Table 39: Required Steel Swaged Pole Strength for MV Overhead Lines (AAAC Covered).....	51
Table 40: Steel Swaged Poles for Overhead Distribution Lines.....	51
Table 41: Maximum Span Lengths for Different Phase Spacing	52

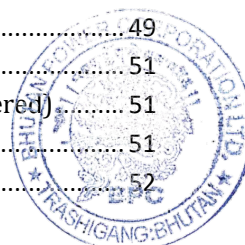


Table 42: Telescopic Galvanized Pole for Overhead Distribution Lines	52
Table 43: Design Data for Low Voltage Overhead Lines 50 mm ² ABC.	53
Table 44: Design Data for Low Voltage Overhead Lines 95 mm ² ABC.	54
Table 45: Standard Steel Swaged Poles used by BPC	55
Table 46: Standard Galvanised Telescopic Poles used by BPC	56
Table 47: Details of 11.2 meter and 12 meter Galvanised Telescopic pole	56
Table 48: Pole fittings for Single Pole Assemblies	59
Table 49: Pole fittings for Double Pole Assemblies	59
Table 50: Pole fittings for Single Pole Assemblies	60
Table 51: Pole fittings for Double Pole Assemblies	61
Table 52: Pole fittings for Single Pole Assemblies	61
Table 53: Pole fittings for Double Pole Assemblies	62
Table 54: Pole fittings for Substation Structure Assemblies	63
Table 55: Minimum Specification for Porcelain Pin Insulators	64
Table 56: Minimum Characteristics of Polymer Pin Insulators	65
Table 57: Details of Pin-End Fittings for Fixing on the Channel	66
Table 58: Minimum Characteristics applied to Porcelain Disc Insulators	66
Table 59: Minimum Characteristics applied to Polymer Disc Insulators	66
Table 60: Minimum Characteristics of the Stay/guy Insulators	67
Table 61: Specification of Stay Set	68
Table 62: Galvanised Steel Stay Wires	69
Table 63: Specification of Shielding Wire	69
Table 64: Characteristics of Bare Overhead Line Conductors	70
Table 65: The Minimum Technical Requirement of the AAAC Covered	70
Table 66: Minimum Technical Requirement of the HV ABC	72
Table 67: Typical Characteristics of Aerial Bundled Conductor	73
Table 68: Current Ratings of Overhead Low Voltage Service Cables	73
Table 69: Typical 33 kV Cable Characteristics	74
Table 70: Typical 11 kV Cable Characteristics:	75
Table 71 : Typical 33 and 11 kV Cable Characteristics.....	75
Table 72: Data on Standard 400 V Underground Cable – Three Phase	76
Table 73: Data on Standard 230 V Underground Distribution Cable – Single Phase	77
Table 74: Standard Specification for Distribution Transformers	77
Table 75: Standard Distribution Transformer Capacities	79
Table 76: Protection of Distribution Transformer	79
Table 77: General Characteristic of the CSS	80
Table 78. Specification of Air Circuit Breaker (ACB)	84
Table 79. Specification of MCCB	84
Table 80: Specification of Surge Arrestors	86
Table 81: Specification of Auto-Recloser	88
Table 82. General Technical Requirement Fault Passage Indicator	89
Table 83: Standard Specification for Medium Voltage Drop Out Fuse Bases	90
Table 84: Fuse Link Rating	91
Table 85: Standard Specification for Medium Voltage Load Break Switches	92
Table 86: Tree Clearance Distances	96

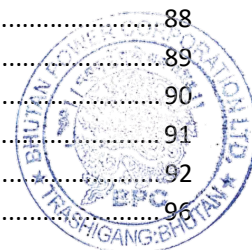


Table 87: Sag-Span Chart – 33 kV, WOLF	102
Table 88: Sag-Span Chart – 33 kV, DOG	103
Table 89: Sag-Span Chart – 33 kV, RABBIT	103
Table 90: Sag-Span Chart – 33 kV, AAAC Covered (111.3sq.mm)	103
Table 91: Sag-Span Chart – 11 kV, WOLF	103
Table 92: Sag-Span Chart – 11 kV, DOG	104
Table 93: Sag-Span Chart – 11 kV, RABBIT	104
Table 94: Sag-Span Chart – 11 kV, AAAC covered (111.3sq.mm)	105
Table 95: Sag-Span Chart – 11 kV, AAAC covered (48.98sq.mm)	105
Table 96: Sag-Span Chart – 11 kV, HV ABC (95 sq.mm)	105
Table 97: Sag-Span Chart – 11 kV, HV ABC (50 sq.mm)	106
Table 98: Sag-Span Chart for Low Voltage ABC	109
Table 99: Maximum Spans for Aerial Bundled Cable	109
Table 100: Acceptable Transformer Medium Voltage Fuse Link Ratings	114
Table 101: Low voltage cable ratings used between transformer and DP	115
Table 102: Max. MCCB Ratings for Three Phase Low Voltage Aluminium Cable Circuits	116
Table 103: Maximum Fuse Link Sizes for ABC Cable	116
Table 104: Distribution Board Rating for Pole Mounted Transformer	118
Table 105: LV Distribution Board Specification for Pad Mounted Transformer	119
Table 104: BPC Standard Direct Connected Meters	120
Table 105: BPC Standard CT Connected Meters	121



INTRODUCTION

The 3rd Edition of Distribution Design and Construction Standard (DDCS) covers the standards for design and construction of Bhutan Power Corporation Limited's (BPC's) distribution and customer service networks. The document is revised incorporating the technical feedbacks from site employees, new designs and additional designs for civil works.

The objectives of the standards are to:

- Standardise BPC's design and construction practices to the extent that is economically practical;
- Promote design and installation practices that minimize electrical hazards and follow best fit good international practices in electricity distribution engineering;
- Develop design practices for economic utilisation of materials. Provide a reference to good engineering practice for use by BPC engineers and technical staff.

The document comprises of three parts:

- (1) The Design Standards
- (2) The Standardization of Equipment
- (3) The Construction Standards



OVERVIEW OF ELECTRICITY DISTRIBUTION IN BHUTAN

The Distribution and Customer Services Department (DCSD) is responsible for construction of Medium Voltage and Low Voltage systems throughout Bhutan. The department is also responsible for operation, maintenance and supply of electricity.

Electricity is generally injected into the distribution networks at a nominal voltage of either 33 kV or 11 kV. However, few networks still operates at 6.6 kV although this is no longer a standard voltage and is not used for new construction. These networks were connected on-grid at low voltage side i.e. at 400 V.

Electricity is supplied to small consumers at a nominal voltage of 400 V for three phase supply or 230 V for single phase supply. Larger consumers are supplied at three phase medium voltage. However, the voltage measured at a consumer's point of supply will vary from the nominal supply voltage depending on the loading on the network and the location of the point of connection. Nevertheless, the network is designed so that the steady state supply voltage to all low voltage consumers will be within 6% of the nominal voltage at all times. Deviations outside this standard voltage range can be expected to occur for short periods of time following a fault on the network or some other abnormal operating conditions.

The medium voltage distribution networks operate at either 33 kV or 11 kV and are used to supply power to consumers. Distribution substations are located throughout the distribution network to step down electricity from 33 kV or 11 kV medium voltages to 400/230 V low voltage to supply power to small consumers.

In rural areas the medium voltage distribution network is generally constructed using overhead bare conductors supported by steel poles. HV ABC and AAAC covered conductors are also used in areas where the MV distribution network falls under protected regions. Distribution substations are generally pole mounted on a two pole structure in rural areas. However, all LV lines are with insulated low voltage aerial cable (LV ABC).

In urban areas the standard medium voltage distribution is either at 33 kV or 11 kV and both medium and low voltage circuits are generally constructed as mixture of overhead and underground system. Distribution substations have historically been built in fenced substation enclosures, but now, new substations like compact packaged substation, Ring Main Units (RMU) etc are also introduced in our system.



1. DESIGN PARAMETERS

1.1 Local Conditions

It is essential that before proceeding with the design aspects of electrical installations, the site conditions are known as best as possible. The table below indicates the general condition where the BPC's equipment shall generally be used:

Table 1: General Local Condition¹

Altitude	200 to 5000 metres
Ambient air temperature <ul style="list-style-type: none">• Maximum• Minimum	40°C -20°C
Design ambient temperature	40°C
Average annual rainfall	1,400 mm
Climate	From tropical to severe winter
Relative humidity	20% to 100%
Isokeraunic level	75 thunder days
Seismic acceleration level <ul style="list-style-type: none">• Horizontal• Vertical	0.1g 0.05g
Snow incidence in winter	150 – 300 mm
Wind pressure on <ul style="list-style-type: none">• Conductors• Supports	0.44 kPa (45 kg/mm ²) 1.91 kPa (194 kg/mm ²)

Note 1: For the purpose of procurement by Procurement Services Department (PSD), there shall be specific requirement given in the tender specification where to use and install the equipment.

1.2 Electrical Design Parameters

The electrical parameters of the equipments in accordance with relevant IEC and IS standards for 33 kV and below are shown in following tables. The values mentioned below are for an altitude of 1000m.

Table 2: Minimum Insulation and Short Circuit Withstand Parameters – Medium Voltage

Nominal System Voltage kV	33	11	6.6
Nominal system frequency (Hz)	50	50	50
Maximum system voltage (kV)	36	12	7.2
Rated impulse withstand voltage (peak) kV	170	75	60
Rated one minute power frequency withstand voltage (rms) kV	70	28	20

Rated short time withstand current (rms) for 3 secs kA	16	20	20
Rated short circuit withstand current (peak) kA	40	50	50
Creepage Distance (mm/kV)	25	25	25

Table 3: Insulation Parameters – Low Voltage

Nominal System Voltage	V	400/230
Nominal system frequency	Hz	50
Maximum system voltage	V	424/244 ¹
Rated one minute power frequency withstand voltage (rms)	V	3000
Rated impulse withstand voltage (peak)	V	7500

Note 1: Phase to Phase / Phase to Neutral

Table 4: System Variation

Parameters permissible at 75 °C		Variation
Voltage Regulation of MV System	33,11,6.6 kV	±10%
Voltage Regulation of LV System	400/230 V	±6%
System Frequency	50 Hz	±1% ¹

Note 1: Maintain the System frequency between 49.5-50.5Hz.. Source : Distribution Code

Table 5: Minimum Air Clearances for Equipment Terminals

Indoor (air filled cable box/connection chambers)		
Voltage in KV	Phase to earth in mm	Phase to phase in mm
LV	20	25
6.6	80	130
11	80	130
33	222	351
Outdoor (External air clearances of terminals mounted on equipment)		
LV	40	75
6.6	140	280
11	140	280
33	320	350

Note 1: Approximate clearances specified in relation to the insulation level of the system voltage.

Source: CBIP Manual on Transformer

1.2.1 De-rating

The values mentioned in this specification are for the normal condition which is below 1000 m altitude. Beyond this limit, it is necessary to de-rate the device. De-rating must be considered;



- For insulation level of external insulation.
- For electrical clearances of two conductive parts measured through air.

1.2.2 Basic Insulation Level (BIL) De-rating According to Altitude

For installation at an altitude higher than 1000 m, the correction method recommended in IEC 60694 is to be used for the purpose of determining withstand test voltages.

1.2.3 Electrical Clearance According to Altitude

If the equipment is specified for operation at an altitude higher than 1000 m, the clearance requirements shall be increased by 1% for every 100 m by which the altitude exceeds 1000 m.

Requirements are given for phase-to-earth; phase-to-neutral and phase-to-phase clearance.

1.3 Mechanical Design Parameters

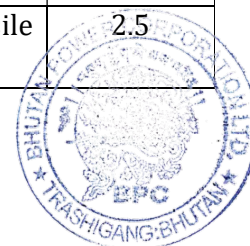
Table 6: Overhead Line Design Parameters

Minimum temperature of conductors	-20°C
Maximum temperature of conductors	75°C
Average everyday temperature of line conductors	15°C
Maximum wind loading on conductors	0.44 kPa
Maximum wind loading on supports	1.91 kPa
Ice loading – radial thickness	10 mm

It may be assumed that ice does not form and accumulate on conductors in high wind conditions. Therefore, lines in areas subjected to snow should be designed to withstand maximum snow and wind loads, but it need not be assumed that the loads will be applied simultaneously.

Table 7: Minimum Factor of Safety (FoS)

Particulars	FoS
Insulator assemblies based on ultimate strength	2
Overhead line steelwork with maximum simultaneous load based on UTS	2
Overhead line support foundations against overturning	2.5
Stay foundations under maximum load	1
Guy wires based on ultimate tensile strength	2.5
Guy wire rods based on ultimate tensile strength	2.5
Steel Poles and Telescopic Poles based on ultimate tensile strength	2
Line conductor (-20 degree, with wind) based on ultimate tensile strength	2.5



1.3.1 Overhead Line Clearances

The minimum clearances and separations to be observed in the design of overhead lines are given in the following table. Lines shall be designed with following minimum clearances.

Table 8: Minimum Overhead Line Conductor Clearances

Particulars	33 kV	11 kV	6.6 kV ¹	LV (bare) ²	LV (ABC)
Ground clearance					
• Across street	6.1 m	6.1 m	6.1 m	5.8 m	5.5 m
• Along the street	5.8 m	5.8 m	5.8 m	5.8 m	5.5 m
• Elsewhere	5.8 m	5.8 m	5.8 m	5.0 m	4.6 m
Separation between phases					
• Horizontal	1.5 m	0.7 m	0.7 m	#	#
• Vertical	1.0 m	0.6 m	0.6 m	0.3 m	#
Clearance from buildings					
• Horizontal (Line passing adjacent the building from nearest object)	1.8 m	1.2 m	1.2 m	1.2 m	#
• Vertical (Line passing above the building from highest object)	3.7 m	2.5 m	2.5 m	2.5 m	#
Sectional clearance	2.8 m	2.6 m	2.6 m	#	#
Minimum approach distances	2.1 m	1.5 m	1.5 m	0.5 m	#
Right Of Way*	12 m	9 m	9 m	7 m	1 ³
Clearances between lines when crossing each other					
• LV	2.44 m	2.44 m	2.44 m	2.44 m	#
• 6.6 kV	2.44 m	2.44 m	2.44 m	2.44 m	
• 11 kV	2.44 m	2.44 m	2.44 m	2.44 m	
• 33 kV	2.44 m	2.44 m	2.44 m	2.44 m	
• 66 kV	2.44 m	2.44 m	2.44 m	2.44 m	
• 132 kV	3.05 m	3.05 m	3.05 m	3.05 m	
• 220 kV	4.58 m	4.58 m	4.58 m	4.58 m	

Source: BEA Safety Code Amendment 2021

Not applicable.

Note 1 & 2: These systems are no more used for new construction; however, the standard may be referred for few existing networks in the system.

Note 3: The same shall be applied to HV ABC.

*The Right of Way clearing shall be executed a minimum twice in temperate and sub-tropical zone and once in all three zones.

Table 9: Vertical Separation of Conductors of Different Voltages on Same Structure

Particulars	Minimum Clearance
33 kV and 11 kV	1.2 m

33 kV and LV	1.5 m
11 kV and LV	1.2 m
33 kV or 11 kV and telephone line (bare)	1.8 m
Communication Line (covered) to 33 kV, 11 kV and LV	0.6 m

It is not a standard practice to construct lines of different voltages on the same poles. However, lines may be constructed in this way where routes for separate lines are not available and where the two lines originate from the same source (i.e. where de-energisation of the higher voltage circuit will result in de-energisation of the lower voltage circuit). The design and route of such lines must be approved by the competent authority before commencing with the construction. Double circuit line with vertical and horizontal configuration is given on drawing no. BPC-DDCS-2023-12 and 13.

1.4 Underground System

Three method of cable burial can be practiced based on the site requirement.

1. Direct Burial Method
2. Trench method
 - (a) Internal BPC
 - (b) Multi Utility
3. Conduit Method

1.4.1 Direct Burial Method

This method involves digging a channel in the ground and laying cables on a bedding of minimum 75 mm sand at the bottom of the channel, and covering it with riddled soil and protecting it by means of tiles, bricks or slabs. UG direct burial installation practices is shown in drawing no. BPC-DDCS-2023-1A

Table 10: Depth of Direct Burial of Underground Cable with or without conduit

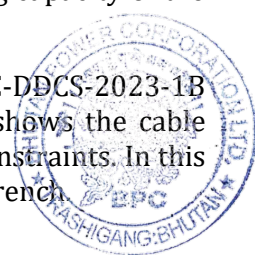
Particulars	Minimum Depth
33 kV	1.0m
11 kV	1.0m
LV Cables and control cables	0.6m

Source : IS 1255,1983 & BEA Safety Code Amendment 2021

1.4.2 Trench method

Cable trench may be adopted based on the specific requirement of the site situation. Cables are either laid on cable tray or by mounting along the walls with the provision of 'J' hooks. The heat generated in the cables is dissipated only through the walls of the trench. Consequently, there is an increase in the temperature of the cables installed and accordingly a proper de-rating has to be applied to the current carrying capacity of the cables installed.

A typical drawing of Internal BPC method is shown in drawing no. BPC-DDCS-2023-1B with power and control cables and drawing no. BPC-DDCS-2023-1C shows the cable trench used in case of ROW issues such as core town area with space constraints. In this trench other utilities along with BPC have a combined cable laying in a trench.



1.4.3 Conduit Method

In designing a conduit system, the maximum pulling design and limits should be considered. Raceway fill, maximum sidewall pressure, jam ratio, and minimum bending radius are design limits which should be examined in designing a proper cable pull. The design limits are explained and sample calculation are done in IEEE 525-2007.

Steel, cast iron, cement or earthenware ducts should be used where cables cross roads. Minimum depth should be maintained below the black top surface so that there is no projection on road surface. The duct should be mechanically strong to withstand forces due to heavy traffic. A typical conduit installation is shown in drawing no. BPC-DDCS-2023-1C

1.4.4 Spacing between Cables

Spacing between multi circuit cables can be reduced by having partitions of bricks etc. Larger the clearance better would be the current carrying capacity.

Table 11: Spacing of Underground Cables

Particulars	Spacing (Horizontal and Vertical)
Power cable to control cables	0.3 metre
Power cable to communication cable	0.4 metre
Power cable to water pipe	0.3 metre
Cables of same class	Overall diameter of the bigger of the two cables

1.4.5 De-rating (Correction Factors) of Cables

Cables laid together must be de-rated, irrespective of whether they are buried in the ground or laid in trenches. The de-rating/ correction factors shall be referred from IEC 60502-2 (Table B.10 to B.23) for temperatures, installation conditions and grouping of cables.



2. MEDIUM VOLTAGE SYSTEM

The voltages adopted for MV and LV distribution system are as follows:

- (a) MV Distribution System Voltage - 33 kV and 11 kV .
- (b) LV Distribution System voltage - 400(3 phase)/230(1 phase) Volts.

2.1 Phase Relationships

The phase relationships between different voltage levels in Bhutan are shown on drawing no. BPC-DDCS-2023-2. It can be seen from this drawing that:

- The MV system leads the transmission voltage system by 30° in the west whereas in the east, the MV system lags the transmission system by 30°.
- The LV system further leads the medium voltage system by 30°.

It is important to maintain this standard phase relationship throughout the network in order to facilitate the relocation of transformers and to ensure ease of parallel operation when required.

2.2 Power Transformers

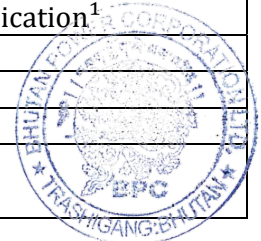
Standard rating of power transformers used in BPC are as follows:

- 1500 kVA
- 2500 kVA
- 3000 kVA
- 5000 kVA.

Power transformers shall be ordered to specifications given below:

Table 12: Standard Specifications for 33/11 kV Power Transformers

Item	Specification			
Transformer rated capacity	1.5 MVA	2.5 MVA	3 MVA	5 MVA
Type of Transformer	Two winding Transformer			
Applicable Standards	IS 2026, IEC 76 (Parts 1 to V)-Power Transformers IS 8468, IEC 60214-Tap changers IS 335, IEC 60296 - Insulating oil			
No load Ratio	33/11 kV			
No. Of Phase	3			
Rated Frequency	50			
Vector Group	Yyn0/Dyn11 depending on network phase.			
Tap Changer	OCTC or OLTC depending on application ¹			
Tap Changer Range	+5% to -5% in 1.25% steps			
Type of Cooling	ONAN			
Ambient Temperature	40°C			
Permissible Temperature Rise <ul style="list-style-type: none">• Winding	55°C			



• Top Oil	50°C			
Impedance at principal tap at 75°C	6% (Latest amendment of international standard)		7% (Latest amendment of international standard)	
Min. Clearances between outdoor ² Bushings [3] • HV P-P / P-E (mm) • LV P-P / P-E (mm)	350/320 280/140			
Min. Clearances between indoor ² Bushings • HV P-P / P-E (mm) • LV P-P / P-E (mm)	351/222 130/80			
System earthing	Solid			
Sound level	60 dB	62 dB	63 dB	65 dB
Core material	(CRGO Silicon steel/ Amorphous Metal ³)			
Primary and Secondary Terminations ⁴	Bushing or cable box as per site requirement.			
Pour point of the transformer Oil	Pour point for new oil should be less than -6 °C			
Break Down Voltage of oil (BDV)	The Minimum BDV for new unaltered oil should not be less than 30 kV and after filtration it should not be less than 60 kV.			
Flash point of Oil	The value of flash point for new transformer oil should be more than 140 °C.			

Note 1: OLTC not recommended for 11 kV and capacity below 5 MVA.

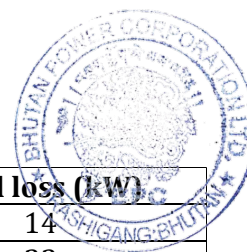
Note 2: Indoor refers to bushings inside a cable box.

Note 3: Amorphous core gives less core loss however weight of the transformer will increase.

Note 4: Neutral bushing at star winding side.

Table 13: Maximum allowable Losses at 75°C ¹

Sl#	Power rating (kVA)	No load loss (kW)	Load loss (kW)
1	1500	2.1	14
2	3000	3.2	22



4	5000	4.6	27
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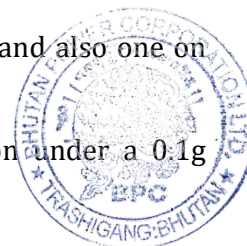
Note 1: These are the maximum allowable losses.

Source: CBIP Manual on Transformer

2.2.1 Fittings and Accessories

33/11 kV power transformers shall be purchased with the following accessories:

- An oil conservator tank with two separate compartments, one for the main transformer and one for the OLTC;
- Oil level gauges for both compartments with potential free contacts for a low oil level alarm;
- Weatherproof dehydrating breathers for each compartment;
- Pressure relief devices for both the transformer and OLTC chambers;
- Gas and oil operated Buchholz relays for both the transformer and OLTC chambers. The relays shall include potential free contacts to provide an alarm in the event of slow gas formation and to both alarm and trip the transformer in the event of fast oil and gas surges;
- A dial type temperature indicator to indicate the top oil temperature in the transformer chamber. This indicator shall include (i) a maximum temperature indicator that can be manually reset; (ii) potential free contracts which are used to alarm on high temperature and trip the transformer on very high temperature; and (iii) a transducer and transmitter engineered to provide two 4-20 mA indication signals, one for the substation control panel and one for a SCADA system;
- A winding temperature indicator with the appropriate sensing, compensating and calibrating devices. This indicator shall include: (i) potential free contacts for an alarm on high temperature and a transformer trip on very high temperature; (ii) a transmitter providing two 4-20 mA signals for the substation control panel and a SCADA system;
- A weatherproof marshalling box for housing all control circuitry, with a minimum degree of protection of IP 55 in accordance with IEC 60529, mounted on the transformer tank; and
- Bidirectional flanged wheels for 1676 mm rail gauge; for 5MVA and 1000mm rail gauge for ratings below 5MVA.
- Earthing pads in two separate locations on the transformer tank and also one on each radiator tank; and
- Earthquake clamps designed to hold the transformer in position under a 0.1g horizontal acceleration and a 0.05g vertical acceleration.



- Set of terminal bushings for HV winding.
- Set of terminal bushings for LV winding.
- Ratings plate and terminal marking plate.
- Tap changer gear.
- Oil filling hole and plug.
- Drain valve with plug.
- Filter valves.
- The transformer shall also include lifting lugs, hauling eyes, jacking pads, inspection manholes and all other accessories necessary to facilitate transport, location in position and ongoing inspection and maintenance.

2.2.2 Voltage Control of Power Transformers

This section gives voltage control of OFF-circuit as well as ON-load type.

OFF-circuit Type Voltage Control

The transformer shall be provided with off-circuit tap changing switch or off-circuit links for varying its effective ratio of transformation whilst the transformer is de-energized. The off-circuit switch handle will be provided with locking arrangement along with tap position indicator, thus enabling the switch to be locked in position. A warning plate indicating transformers to be operated in de-energized state shall be fitted.

ON-load Type Voltage control

The transformer is provided with voltage control equipment of the tap changing type on on-load without producing phase displacement. For such transformers, equipment for local and remote electrical and local manual operation shall be provided.

2.2.3 OLTC Cabinet

A separate lockable OLTC cabinet with a degree of protection of at least IP65 in accordance with IEC 60529 shall be provided. This cabinet shall house the tap changer motor drive mechanism and associated controls for manual and local operation and shall include but not be limited to:

- A mechanism to permit local operation of the tap changer in the event of an electrical control failure;
- A local/remote selector switch;
- A raise/lower control switch;



- An emergency stop push-button;
- A tap position indicator;
- A tap change counter;
- A tap change in progress indicator;
- A position transmitter for remote indication of tap position;
- A step-by step control relay to ensure that the tap changes by only one position for each raise/lower operation; and
- A run-through protection to protect against failure of the step-by-step control relay;
- A circuit breaker/contactors with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor.
- Cubicle light with door switch.
- Space heaters to prevent condensation of moisture.
- Padlocking arrangement for hinged door of cabinet.
- Cable terminal glands for power and control cables to the OLTC gear.

2.2.4 Remote Tap Changer Control Panel

The RTCC panel shall house actuating switch for electrical raise/lower control, tap position indicator, signal lamps for "Tap change in progress" and "Tap changer out of step" and all other auxiliary devices for remote electrical control of the OLTC. The RTCC panel shall be located in control room. The RTCC panel shall be provided with all requisite switches, relays, control equipment and other required items, including but not limited to the following:

- Automatic Voltage Regulator along with all associated accessories and line drop compensation.
- Control switch for raise or lower.
- Auto or manual selector switch.
- Tap position indicator
- Facia alarm annunciator with all standard features.
- Audio signal and indicating lamps for tap change in progress, upper and lower limits of taps.
- Digital WTI and OTI



- Adequate contracts on main relays and necessary auxiliary relays for remote annunciation, control and SCADA and other applications.
- HV and LV digital voltage indicators with selector switch, adequate terminal blocks, fuses, space heater and cubicle illumination CFL etc.

2.2.5 OLTC Control Scheme

The control scheme shall provide for Auto and Manual control of the OLTC, the former through an Automatic Voltage Regulator (AVR) along with necessary auxiliary equipment like line drop compensator etc. and the latter with requisite local / remote operation features. The control feature shall provide the following:

Local Electrical Control

- When the selector switch is in 'local' position, it shall be possible to operate the 'raise-lower' control switches. Remote control of the raise-lower functions shall be prevented.
- When the selector switch is in 'remote' position the local OLTC control cabinet mounted 'raise-lower' switch shall be in-operative. Remote control of the raise/lower function shall be possible from the remote control panel. The 'local-remote' selector switch shall have at least two spare contacts per position which are closed in that position but open in the other position.
- A 'raise-lower' control switch/push button shall be provided in the local OLTC control cabinet. This switch shall be operative only when 'local remote' selector switch is in 'local' position.
- An OFF-ON tap changer control switch shall be provided in the local OLTC control cabinet of the transformer. The tap changer shall be inoperative in the OFF position. Also the OFF-ON switch shall have at least one spare contact per position which is closed in that position but open in the other position.

Manual Control

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing at ground level. The mechanism shall be complete with the following:

- Mechanical tap position indicator which shall be clearly visible from near the transformer.
- A mechanical operation counter.
- Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.
- The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operating mechanism shall be labeled to show the direction of operation for raising the HV terminal voltage and vice-versa.



Remote Electrical Parallel Control

The OLTC control scheme offered shall have provision of remote electrical group control during the parallel operation of transformer. This is in addition to independent control of OLTC as mentioned above:

- (i) A four position selector switch having Master, Follower, Independent and off position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in Master, Follower or Independent mode.
- (ii) Out of step relays with timer contacts shall also be provided to give alarm and indication in case tap position in all the transformers under group control are not in same position.
- (iii) **Master Position-** If the selector switch is in Master position; it shall be possible to control the OLTC units in the follower mode by operating the controls of the master unit. Independent operation of the units under Follower mode shall have to be prevented. However, the units under independent mode will be controlled independently.
- (iv) **Follower Position-** If the selector switch is in Follower mode, control of OLTC shall be possible only from panel of the Master unit.
- (v) **Independent Position** -In this position of Selector Switch, Control of OLTC of individual unit shall only be possible.

2.2.6 Auxiliary Power Supply for OLTC

Two auxiliary power supplies, 415 volts shall be provided for OLTC and power circuit. All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch for on load tap changer control and power circuits. Design features of the transfer switch shall include the following:

- (i) Provision for the selection of one of the feeder as normal source and other as standby.
- (ii) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.
- (iii) Indication to be provided for failure of normal source and for transfer to standby source and also for failure to transfer.
- (iv) Automatic re-transfer to normal source without any intentional time delay following re-energisation of the normal source.
- (v) Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

2.2.7 Protection of Power Transformers

Power transformers of capacity indicated in this specification shall have following protections:



- Circuit breakers on both primary and secondary sides.
- Differential protection (87) for transformers rated 5 MVA and above. This relay requires PX class CT connections from both primary and secondary sides.
- IDMT trip over current relay with high elements on both primary and secondary sides.
- Oil Temperature indicator with one electrical contact for alarm and trip contact.
- Buchholz relay with alarm and trip contact.
- Winding temperature indicator with two electrical contacts for (a) alarm and (b) trip.
- Lightning arrester on both primary and secondary sides when the transformer is outdoors and connected to overhead lines.
- Oil surge protection for OLTC (if provided) with diverter tank with trip contact.
- Pressure relief device with trip contact.
- Oil level indicator with alarm contacts shall be provided.

Typical transformer protection scheme is shown on drawing no. BPC-DDCS-2023-3.

2.3 MV Switchgears

The main component of MV switchgear consists of Circuit Breakers, CTs, PTs, Isolators and instruments.

2.3.1 Compulsory rated characteristics of Switchgear

Rated voltage

Rated voltage is always greater than the operating voltage. Standardized values for U_r (kV) are: 7.2 kV - 12 kV - 36 kV.

Rated normal current

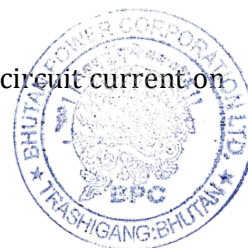
With the circuit breaker always closed, the load current must pass through it in compliance with a maximum temperature value as a function of the materials and the type of connections. IEC 60694 sets the maximum permissible temperature rise of various materials used for an ambient air temperature of no greater than 40°C

Rated short-time withstand current

This is the standardized rms value of the maximum permissible short-circuit current on a network for 1 or 3 seconds and is calculated as follows:

$$I_{sc} = (S_{sc} / \sqrt{3}) \times (1/U)$$

S_{sc} : short-circuit power (in MVA)



U : operating voltage (in kV)

I_{sc} : short-circuit current (in kA)

Standardized values of rated short time withstand current are 6.3 - 8 - 10 - 12.5 - 16 - 20 - 25 - 31.5 - 40 - 50 kA.

Rated peak withstand current

The maximum value that a circuit breaker is capable of making and maintaining on an installation in short-circuit. The peak value of the short-time withstands current is equal to 2.5 times of I_{sc} for 50 Hz.

Rated supply voltage for closing and opening devices and auxiliary circuits

Values of supply voltage for auxiliary circuits are (a) for direct current (dc): 24 - 48 - 110 or 220 volts, (b) for alternating current (ac): 110 - 230 volts.

Rated operating sequence

Rated switching sequence according to IEC, O - t - CO - t' - CO.

O : represents opening operation

CO : represents closing operation followed immediately by an opening operation. Three rated operating sequences exist. (a) slow: O - 3 min - CO - 3 min - CO; (b) quick 1: O - 0.3 s - CO - 3 min - CO; (c) quick 2: O - 0.3 s - CO - 15 s - CO

Rated short-circuit breaking current

This is the maximum short circuit current which a circuit breaker can withstand before opening its contacts under fault condition. Values of rated short-circuit breaking current are 6.3 - 8 - 10 - 12.5 - 16 - 20 - 25 - 31.5 - 40 - 50 - 100 kA.

Rated short-circuit making current

This is the maximum short circuit current which a circuit breaker can withstand after closing its contacts under fault condition. Normally value of short circuit making current is 2.5 times more than short circuit breaking current.

Table 14: Minimum General Technical Parameters of the MV Switchgears

Description	Unit	33 kV switchgear	11 kV switchgear
Rated voltage , No. of phase and rated frequency	kV/Hz	36 kV, 3 phase, 50 Hz	12 kV, 3 phase, 50 Hz
Type		Indoor/Outdoor, Metal-enclosed, compartmentalized, draw out type.	
Rated short duration power frequency withstand voltage	kV	70	28
Rated Lightning impulse withstand voltage	kV _{peak}	170	75

Description	Unit	33 kV switchgear	11 kV switchgear
Rated normal current of bus bars under design ambient temperature of 30°C and material of bus bar.	A	630, 800, 1250, Copper	630, 800, 1250, Copper
Rated short time withstand current and time	kArms	25kA for 3 Sec	25 kA for 3 Sec
Rate peak withstand current*	kApeak	2.5 times of kA rms	2.5 times of kA rms
Min Thickness of the sheet steel in mm Cold rolled (Frame/Enclosure/Covers)	Mm	2.5	2.5
Degree of Protection Interior and exterior)		IEC 60529	IEC 60529
Colour finish shade		RAL 7032	RAL 7032

Note: De-rating shall be carried out accordingly if an installation condition differs from normal condition.

2.3.2 Circuit Breakers

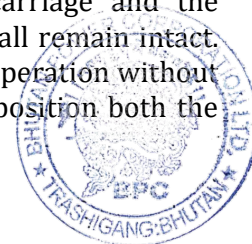
In BPC, 33 kV and 11 kV circuit breakers are generally vacuum type interrupters. However, there are also few circuit breakers installed in the system which works on compressed air technology.

Table 15: Selection of Circuit breakers

Rated Voltage	Choice of Circuit Breaker	Arc Quenching Medium
400/230 Volts	Air-Break C.B	Air at Atmospheric pressure
11 & 33 kV	Vacuum C.B, SF6 C.B	Vacuum, SF6
11 & 33 kV	Air-Break C.B	Compressed Air

Indoor circuit breakers shall be of the withdrawable type. The circuit breaker interrupters, along with their operating mechanisms, shall be mounted on a withdrawable-wheeled carriage moving on guides designed to align correctly and allow easy movement. The power circuits are connected to the withdrawable carriage by an insulated plug and socket arrangement and the control circuits on the carriage are also connected to the circuitry within the fixed switchboard housing through multi-pin plugs and sockets.

The wheeled circuit breaker carriage shall have three positions, “service”, “test” and “withdrawn”. In the “service” position the circuit breaker is fully operational, and closing the interrupter will energise the controlled power circuit. In the “test” or intermediate position the high voltage contacts between the circuit breaker carriage and the switchboard busbars shall be disconnected but the control circuits shall remain intact. Hence, the circuit breaker shall be capable of being tested for correct operation without actually energising the controlled power circuit. In the “withdrawn” position both the power circuit and the control circuits shall be disconnected.



Busbar sockets within the stationary housing shall be fitted with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn. Padlocking facilities shall be provided so the shutters can be manually locked in the closed position when the circuit breaker carriage is fully withdrawn.

The circuit breaker shall be fitted with electrical and mechanical interlocks. The mechanical interlock shall prevent the circuit breaker carriage from being withdrawn from or replaced in its housing unless the interrupter is in the open position. An electrical interlock shall ensure that it is not possible to close the interrupter when the circuit breaker is in the service position unless the auxiliary circuits in the carriage are connected to those in the switchboard housing. Furthermore, the tripping and closing circuits for each circuit breaker cubicle shall be electrically interlocked.

Facilities shall be provided to allow each outgoing primary circuit and each switchboard bus section to be earthed, either through earthing switches or a truck mounted earthing device. All earthing facilities shall be mechanically interlocked to prevent the accidental earthing of live circuits or busbars.

Circuit breaker control shall be on 48 V DC or 110V as per the availability of DC supply at the site.

Table 16: Minimum General Specification for Medium Voltage Circuit Breakers

Particulars	33 kV	11 kV
Applicable Standards	IS 13118, IEC 60466, IEC 60694, IEC 62271-100	
Interrupter Type	Vacuum, SF6	
Rated circuit current (A)	630	630
Rated Operating sequence	O-3 sec -CO-3 min-CO	
Rated short time withstand current (kA)	25kA for 3 sec	25kA for 3 sec
Rated short circuit breaking current (kA)	25	25
Rated peak making current (kA _{peak})	62.5	62.5
Min. no. of Auxiliary contacts	6NO + 6 NC after internal use by manufacturer	6NO + 6 NC after internal use by manufacturer
Type of operating mechanism		
Normal	Spring charging for closing and tripping	Spring charging for closing and tripping
Emergency	Manual & spring charged for closing and tripping	Manual & spring charged for closing and tripping
Auxiliary control voltage		
Closing coil and tripping coil	48V/110V DC	48V/110V DC
Spring charging Motor	48V/110V DC	48V/110V DC
Space Heater and lighting	230V AC	230V AC
Earthing Switch	Earthing truck	Earthing truck
Following Protection features shall be provided for the circuit breakers		



- Master trip relay
- Trip circuit supervision

2.3.3 Current Transformer

Rated primary current (I_{pr})

The rated primary current (I_{pr}) will always be greater than or equal to the operating current (I) for the installation. Standardized values: 10 - 12.5 - 15 - 20 - 25 - 30 - 40 - 50 - 60 - 75 - 80 - 100 - 150 - 200 - 250 - 300 - 400 and their multiples.

For metering devices, the rated primary current must not exceed 1.5 times the operating current.

Rated secondary current (I_{sr}) 5 or 1 A

General case: (a) for local use $I_{sr} = 5$ A. (b) for remote use $I_{sr} = 1$ A. Using 5 A for a remote application is not forbidden but leads to an increase in transformer dimensions and cable section due to line loss.

Accuracy class

Metering: class 0.5s; Over current protection: class 5P; Differential protection: class X.

Real power of CT provided in VA

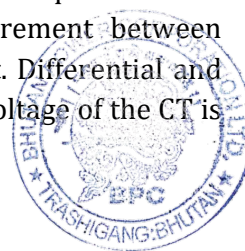
This is the sum of the consumption of the cabling and that of each device connected to the CT secondary circuit. The standardised values of rated output are: 2.5 - 5 - 10 - 15 - 30 VA.

Safety factor (SF)

Protection of metering devices in the case of a fault is defined by the safety factor SF. The value of SF will be generally chosen to be less than 5 or 10. SF is the ratio between the limit of rated primary current (I_{pl}) and the rated primary current (I_{pr}). I_{pl} is the value of primary current for which the error in secondary current = 5 %.

PX Class CTs

This core is used particularly where current balance is precisely required to be maintained. In differential protection, balance is the prime requirement between secondary currents of associated CTs of either side of the equipment. Differential and restricted E/F Protection of transformers need such CTs. Knee point voltage of the CT is of valid importance.



2.3.4 Potential Transformer

Rated voltage factor

Generally, voltage transformer manufacturers comply with (a) VT phase/earth 1.9 for 8 h and 1.5 for 30 sec and (b) VT phase/phase 1.2 continuous.

Rated primary voltage

Voltage transformers will be connected either (a) phase to earth - $\frac{33 \text{ kV}}{\sqrt{3}} / \frac{110 \text{ V}}{\sqrt{3}}$ or (b) phase to phase - 33 kV/110 V.

PT Accuracy Class

For metering 0.5 and for protection Classes 5P

2.3.5 Energy Metering

Energy meters are provided either on HV or LV side of the transformer as per supply rule. Modern meters are built with following features:

- Facility for active energy measurement (both export and import)
- Facility for reactive energy measurement (both export and import)
- RS 232/RS 485/optical communication ports for connecting data acquisition systems.
- Period block energy reading for pre-defined periods (typically for 15/30 minute periods)
- Relay output for alarm/tripping based on power factor/maximum demand/overload etc.
- Load surveying for demand forecasting.
- Local and remote communication features.



Table 17: General requirement of HT Energy Meters¹

Description	Particulars
Applicable standards	IEC 62053-22, IS 14697
Accuracy class	0.5
Basic current	1A or 5A
Rated voltage	63.5V (Phase to neutral)
Rated frequency	50Hz
Measure energy values	Active, Reactive and Apparent
Max. demand reset provisions	Following max. demand resetting options will be provided: <ul style="list-style-type: none"> Resetting through MRI/Laptop capable of communicating with the meter. Automatic reset at the end of the every month
Data retention by NVM	Minimum 10years data retention even in unpowered condition
AMR/RMR facility	Meter can be read remotely using GPRS/GSM modem
Communication ports	<ul style="list-style-type: none"> Optical communication port for data downloading using MRI/LAPTOP/MODEM. Separate MODBUS based RS485 port for SCADA application.
Sealing provisions	2 sealing arrangements on meter body, 2 sealing arrangements on meter terminal cover and one sealing arrangement on optical port shall be provided.
Anti tamper features	Anti tampered features shall be provided
Commissioning type for CT & PT	Meters will be secondary commissioned type i.e. meters will record and display parameters as per actual voltage and currents available at secondary of PT and CT.
Material of meter body	High grade engineering plastic
Meter power supply body	Self powered and Aux supply of single phase AC or input from power pack (DC)
Rating plate details	Bhutan Power corporation Limited Purchase order no.& date Supplied by: manufacturers name Meter serial no. With bar code Rest details will be as per international standards

Note 1: Bi-directional energy meters shall be employed for multiple sources.

The typical connection diagram for three-phase three-wire meter and three-phase four-wire meter is shown on drawing no. BPC-DDCS-2023-4.

2.3.6 General Requirement of Protection Relays

Numerical protection relays shall incorporate the following features:



- An interface to permit local setting of the relay as well as a local LED/LCD display to provide a local indication of relay status and key power system parameters. The local controls shall be password protected to prevent unauthorised changes to the relay settings and the Head of the O&M Unit under the concerned ESD will be authorised to change the password.
- A real time display of selected instantaneous measured and derived parameters relating to the state of the system being protected. User selected measured parameter values shall be available on the LCD display on the front of the relay and also remotely in accordance with user requirements;
- An internal event and disturbance recorder using non-volatile memory. The disturbance recorder shall record the sampled values of all measured parameters as well as at least eight user selectable digital signals. There shall be sufficient storage for at least five fault events and all disturbance recorder records shall be date and time stamped.
- A self monitoring and alarming system that continuously supervises the correct operation of the relay and provides an alarm signal should an internal fault develop. This feature shall not affect the relay availability, in that when a system fault occurs the self monitoring feature shall be immediately interrupted to allow the relay to check and respond to the system fault.
- A local RS232 communication port that can be used for configuring relay settings and programmable scheme logic, if any, using a portable computer. It shall be possible to use this port to locally extract event, fault and disturbance recorder information.
- An RS485 communications port that can be used for permanent connection to a network control or data acquisition system. It shall be possible to use this port for remotely configuring the relay, downloading event and fault recorder information and for continuously monitoring measured analogue values.
- Each protection relay shall be supplied from a separate DC circuit. Where duplicate or redundant protection schemes are used, each scheme shall be connected to a different DC supply bus. Preferably each scheme shall be from a different manufacturer but shall be compatible for integration.



2.4 Gas Insulated Switchgear

These are fixed type metal enclosed designs and do not have withdrawable parts. Gas insulated switchgear is usually recommended for use at high altitude because HV parts are located inside hermetically sealed gas compartments and atmospheric conditions have no influence on insulation of the HV parts. Mostly, 36 kV GIS has been installed in BPC system in high altitude areas due to less space requirement and no need of de-rating the equipment at high altitude. GIS comprised of following equipment:

- Circuit breakers
- Bus bars
- Disconnecter with earthing switch
- Current transformer
- Voltage transformer
- Transition between SF₆ GIS and XLPE cable terminations.
- SF₆ Gas
- Supporting steel structures
- Complete earthing system etc

Circuit breaker, Busbar and disconnecter with earthing switch shall be in SF₆ gas in separate compartments.

2.5 Control and Interlocking Schemes for MV Switchgear

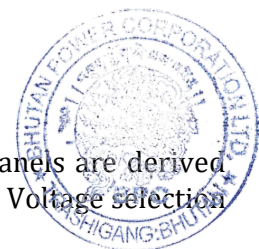
MV switchgears are used for switching MV loads through associated control, measuring, protective and regulating equipment. A variety of control and interlocking schemes are used to achieve the above stated objectives. Following schemes are commonly used:

- Tripping schemes
- Trip circuit supervision
- Voltage selection schemes
- Synchronizing schemes

Tripping schemes are frequently used schemes and is associated with breaker whereas last two schemes are application specific schemes.

2.5.1 Voltage Selection Scheme For Two Incomers

Voltage signals to instruments and meters mounted on switchgear panels are derived from PTs. These PTs can be either bus-connected or feeder connected. Voltage selection



scheme is not required for bus-connected PTs because even if either of the incoming supply is off, there will be continuous PT supply from the bus with bus coupler closed. In case of feeder PTs, in normal operation, the PT of each bus section feeds the voltage signal to feeders connected to respective bus sections. However, in order to take care of a fault in one incomer panel, the PT voltage signal to this section may have to be fed from the PT of another section (other incomer) with the bus coupler being closed. This has led to need of voltage selection schemes which can be achieved either by using breaker auxiliary contacts or by using one under voltage relay as shown in drawing no. BPC-DDCS-2023-5.

2.5.2 Synchronizing Schemes

In order to ensure the two AC supplies are correctly paralleled, the voltages, frequencies and phase difference of the two supplies must be within acceptable limits. The PT secondary voltage is used for monitoring purposes. The check synchronizing relay contact should be connected in parallel with the circuit breaker closing circuit. It ensures that the difference in the incoming and running voltages, frequencies and phases are within pre-selected limits before interconnecting the two sections of a power system through bus coupler. The number of synchronizing relay will depend on the location of the PTs. If feeder PTs are provided at incomer side, there shall be individual synchronizing relay on each breaker (incomers and buscoupler) whereas for bus PTs, only the bus coupler breaker shall maintain synchronizing relay. The scheme is shown in drawing no. BPC-DDCS-2023-6.



3. DISTRIBUTION SYSTEM DESIGN

3.1 Distribution System Arrangements

The following three standard types of distribution system arrangement are used in Bhutan:

3.1.1 Underground Systems

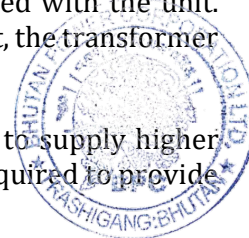
The underground MV network operates at 33 kV&11 kV. New construction shall be arranged as shown in drawing no.BPC-DDCS-2023-7 (Type 1 design) or drawing no.BPC-DDCS-2023-8 (Type 2 design).

a. Type 1 Design

The Type 1 design incorporates packaged substations. Each substation includes a RMU comprising two 11 kV load break switches and a fuse switch, a transformer and a LV distribution panel. The packaged substations are configured in an open 11 kV ring arrangement as shown in the drawing. In the event of a fault, the affected circuit will be isolated at the zone substation end and supply to all distribution substations up to the normally open point on the ring will be lost. Manual switching will be necessary to isolate the faulted area before supply can be restored to consumers that are not directly affected by the fault. Fault indicators should be installed in each RMU to assist fault finding. This arrangement is suitable for urban residential areas with relatively low load densities.

When planning underground distribution systems with Type 1 design, the following should be noted.

- Medium voltage feeders shall generally use a standard 11 kV cable size of 150 mm² throughout the feeder length. Two adjacent feeders shall be connected back to back through a normally open ring main switch to form the normally open ring arrangement. Hence in the event of a cable or distribution substation fault, the healthy portion of a feeder can be back fed from the adjacent feeder.
- Each distribution substation transformer shall be connected in an in/out arrangement through an SF₆ insulated ring main unit. The ring main unit shall comprise two load break switches, one on each incoming supply, and a fuse switch or vacuum circuit breaker to protect the transformer. Vacuum circuit breakers shall be used for transformer protection on transformers rated 500 kVA and above and fuse switches for transformers rated below 500 kVA.
- For normal distribution requirements, a standard distribution substation capacity of 250 kVA shall be used. The substation shall be a ground mounted packaged unit, prefabricated by the manufacturer in an enclosure supplied with the unit. The package unit shall include the medium voltage ring main unit, the transformer and a low voltage distribution board.
- Substations with a capacity of 500 kVA or above may be used to supply higher individual loads in which case the consumer will normally be required to provide



land or indoor accommodation for the substation. Such substations need not be compact substation units but shall include (i) a separate metal clad ring main unit, (ii) a pad mounted distribution transformer and (iii) an LV distribution cabinet. All units shall be free standing, suitable for indoor or outdoor installation and interconnected by cable. Hence the detailed layout is flexible and shall be arranged to suit the accommodation available.

- The maximum feeder current for urban distribution shall be limited to 200 A (4 MVA) under normal operating conditions. However, this current may be increased to 250 A (5 MVA) under abnormal switching arrangements.
- The ring main units shall be metal clad and SF₆ insulated. The load break switches shall have a minimum continuous current rating and load break capacity of 630 A. Ring main units shall be purchased with inbuilt fault indicators, to make it possible to locate a fault without sectionalising the feeder.
- Ring main units shall be supplied with integral earth switches for use during maintenance and fault repair.

As for the Type 1 design, transformers installed indoors should be either oil/ dry-type insulation with plug-in type HT bushing.

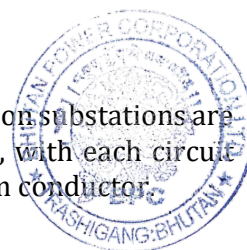
b. Type 2 Design

This arrangement uses compact, extensible 11 kV switchgears which can be installed outdoor. The distribution transformers may be located away from the switchgear and connect switchgear through underground cable. This arrangement utilises a closed ring and through the use of circuit breakers instead of load break switches and directional, definite time protection, which will isolate the faulted part of the distribution circuit automatically so that supply to consumers will not be affected directly by a fault. However, this design is more expensive than the open ring and the number of switchgear sites in the circuit must be limited to six in order to avoid protection coordination problems. The arrangement is suitable for commercial and industrial areas that have a high load density and require a high level of supply reliability.

When using this arrangement, 11 kV cable sizes for both the main ring and between the switchgear and individual transformers should be selected on the basis of the loads to be supplied. Designers should also ensure that the maximum 11 kV voltage drop is limited to 5% when the loop is operating with one end open. Note that the 70mm² cable has a limited fault rating and should not be used within 2 km of a zone substation.

3.1.2 Overhead Distribution Systems

Overhead distribution network can be either 33 kV or 11 kV. Distribution substations are pole mounted and can feed up to four overhead low voltage circuits, with each circuit comprised of 50 mm², 95 mm² and 120 mm² aerial bundled aluminium conductor.



Three types of typical substations that are used in BPC are as follows.

Type A: (drawing no. BPC-DDCS-2023-9) is for a substation at a termination pole,

Type B: (drawing no. BPC-DDCS-2023-10) is for a through pole with pin insulators,

Type C: (drawing no. BPC-DDCS-2023-11) is for a strain pole at angle locations

The design allows for the transformers to be mounted at a sufficient height above the ground that fenced enclosures are not necessary. The LV distribution cubicle should nevertheless be locked.

Transformer LV feeder cubicles shall have a degree of protection of IP 55 or better with bottom cable entry to avoid water ingress. The minimum panel thickness shall be 2.5 mm, and there shall be a removable gland plate of minimum 3 mm thickness. There shall be a lockable hinged door with a minimum thickness of 2 mm. Separate aluminium phase and neutral busbars shall be provided.

LV feeder cubicles installed at rural substations shall include an incoming Moulded Case Circuit Breaker (MCCB) rather than a fuse to provide overload protection for the transformer and also provide a single point at which the transformer can be off-loaded. Protection of outgoing LV circuits on distribution systems shall use High Rupturing Capacity (HRC) fuses, which are more cost effective and offer better short circuit protection.

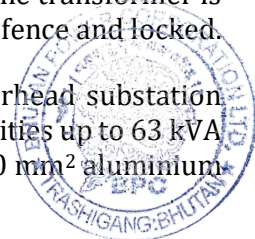
The standard overhead distribution substation design does not include a load break switch in series with the MV drop out fuses. The drop out fuses are designed to be opened and closed with an operating stick with the source side of the fuse base energised, and the omission of the load break switch is consistent with international good practice. However, the drop out fuse is not designed to be used as a load break switch and the operator must off-load the transformer, using the LV incoming MCCB or air circuit breaker (ACB), before disconnecting or replacing the fuse links.

3.1.3 Mixed Distribution Systems

Mixed distribution systems are fed from the overhead network and use the standard double pole distribution substation arrangement. However, the outgoing LV circuits are generally underground, although in some situations a mixture of overhead and underground LV circuits may be used.

The substation arrangement is similar to that for rural distribution substations as described in Section 3.1.2 However, only transformers rated at 125 kVA and below shall be pole platform mounted. Transformers rated above 125 kVA should be pad mounted at the base of the two pole structure. In this case the LV distribution pillar should also be pad mounted in a convenient location close to the transformer. When the transformer is pad mounted the substation will need to be enclosed by a 2 metre high fence and locked.

For both rural and mixed distribution systems the design of the overhead substation structure is standardised as much as possible. For all transformer capacities up to 63 kVA the LV cable between the transformer and the distribution cubicle is 70 mm² aluminium conductor, but above 63 kVA larger size cable may be used.



Transformer LV feeder cubicles shall have a degree of protection of IP 55 or better with bottom cable entry to avoid water ingress. The minimum panel thickness shall be 2.5 mm, and there shall be a removable gland plate of minimum 3 mm thickness. There shall be a lockable hinged door with a minimum thickness of 2 mm. Separate aluminium phase and neutral busbars shall be provided.

3.2 Voltage Drops

The nominal standard voltage at the point of supply to a LV consumer is 400/230 V. The network shall be designed so that this voltage does not vary by more than $\pm 6\%$ under normal operating conditions. This is achieved as follows:

- The MV network should be designed so that the voltage will not vary by more than $\pm 10\%$. In practice the maximum voltage drop in the medium voltage network should be limited to $\pm 5\%$.
- Distribution transformers shall be specified with a nominal voltage ratio of 33/0.415 kV or 11/0.415 kV and with a No Load Tap Changer on the medium voltage side, with a tap range of $\pm 5\%$ in 2.5% steps. This applies to both urban and rural systems. The transformer taps are used to compensate for any voltage drop on the medium voltage network and should not be used to compensate for excessive voltage drop on the LV system, as this could result in regulation problems.
- The output voltage of a transformer reduces with load due to the transformer's internal impedance. The use of transformers with a nominal secondary voltage of 415 V ensures that the terminal voltage will not fall below 400 V at full load, while at low load the output voltage should not rise above the $+6\%$ tolerance.
- The LV network is then designed for a maximum voltage drop of $\pm 6\%$ between the transformer terminals and the customer point of supply. This is achieved by limiting the voltage drop in BPC's low voltage distribution network to $\pm 4\%$ and the voltage drop in the consumer's service line to $\pm 2\%$.

3.2.1 Maximum Length of MV Overhead Lines

The key electrical and mechanical characteristics of BPC's standard overhead line conductors for MV distribution are shown in table 64, table 65 and table 66. MV overhead lines should be designed so that, at maximum design load, the conductor thermal rating is not exceeded and the voltage drop is limited to $\pm 5\%$.

In determining the maximum design load adequate provision should be made for future load growth. In general, for overhead lines, the maximum design load should be not less than twice the forecast initial load to be serviced by the distribution network. Where appropriate, provision should also be made for the additional load from potential future line extensions to serve un-electrified households.

Where overhead lines service rural areas, voltage drop is likely to govern the line design. The maximum circuit lengths for three phase, 33 kV and 11 kV overhead lines, to give a

5% voltage drop at maximum design loads are shown in following tables. The tables assume an 85% power factor and an even distribution of load over the length of the line. Should the load be concentrated at the end of the line, then the maximum line length will be one half that shown in the tables below.

Table 18: Maximum Circuit Length of 33 kV Overhead Lines

Design Load (MW) ¹	Current (A) ²	Maximum Circuit Length (km) ³		
		WOLF	DOG	RABBIT
1	21	136.8	107.6	60.1
2	41	68.4	53.8	30.0
3	62	45.6	35.9	20.0
4	82	34.2	26.9	15.0
5	103	27.4	21.5	12.0
6	123	22.8	17.9	10.0
7	144	19.5	15.4	8.6
8	165	17.1	13.4	7.5
9	185	15.2	12.0	6.7
10	206	13.7	10.8	6.0

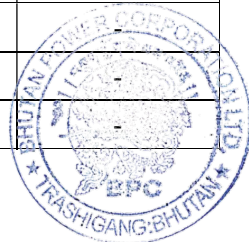
Notes:

1. Maximum after diversity circuit demand at 85% power factor.
2. Maximum current at source of supply.
3. Calculation assumes that the load is evenly distributed along circuit, that the maximum voltage drop is 5%, and that the line voltage drops given in table 64 apply.

As a general rule WOLF or DOG shall be used for 33 kV feeder backbones and DOG or RABBIT for spurs.

Table 19: Maximum Circuit Length of 11 kV Overhead Lines

Load (MW) ¹	Current (A) ²	Maximum Circuit Length (km) ²		
		Wolf	Dog	Rabbit
1	62	15.2	12.0	6.7
2	123	7.6	6.0	3.3
3	185	5.1	4.0	2.2
4	247	3.8	3.0	1.7
5	309	3.0	2.4	1.3
6	370	2.5	2.0	-
7	432	2.2	1.7	-
8	494	1.9	-	-
9	556	1.7	-	-



Notes:

1. Maximum after diversity circuit demand at 85% power factor.
2. Maximum current at source of supply.
3. Calculation assumes that the load is evenly distributed along circuit, that the maximum voltage drop is 5%, and that the line voltage drops given in table 64 apply.

The 11 kV backbone feeders shall generally use dog conductor but may use wolf if the line length is too long or anticipate higher load growth to avoid voltage drop in future. Spur line shall be constructed of dog or rabbit depending on the length and design load.

Table 20: Maximum Circuit Length of HV ABC cable for 11 kV

Load (MW) ¹	Current (A) ²	Maximum Circuit Length (km) ³	
		95sq.mm	50sq.mm
1	62	11.9	6.2
2	123	6.0	3.1
3	185	4.0	2.1
4	247	3.0	1.5
5	309	2.4	1.2
6	370	2.0	-
7	432	1.7	-

Notes:

1. Maximum after diversity circuit demand at 85% power factor.
2. Maximum current at source of supply.
3. Calculation assumes that the load is evenly distributed along circuit, that the maximum voltage drop is 5%, and that the line voltage drops given in table 66 apply.

33 kV & 11 kV covered conductors are appropriate in dense urban areas where underground cable is not feasible or in forested areas where vegetation control is a problem. Distribution system design for such areas should be considered on a case by case basis and the size of ABC cable should be selected on the basis of the forecast demand and the overhead line conductor or underground cable used on the same circuit.

Table 21: Maximum Circuit Length of 33 kV AAAC Covered

Design Load (MW) ¹	Current (A) ²	Maximum Circuit Length (km) ³		
		49.5 sq.mm	111 sq.mm	158 sq.mm
1	21	81.6	110.4	133.7
2	41	40.8	55.2	66.9
3	62	27.2	36.8	44.6
4	82	20.4	27.6	33.4
5	103	16.3	22.1	26.7
6	123	13.6	18.4	22.3
7	144	11.7	15.8	19.1

Design Load (MW) ¹	Current (A) ²	Maximum Circuit Length (km) ³		
		49.5 sq.mm	111 sq.mm	158 sq.mm
8	165	10.2	13.8	16.7
9	185	9.1	12.3	14.9
10	206	8.2	11.0	13.4

Notes:

1. Maximum after diversity circuit demand at 85% power factor.
2. Maximum current at source of supply.
3. Calculation assumes that the load is evenly distributed along circuit, that the maximum voltage drop is 5%, and that the line voltage drops given in table 65 apply.

Table 22: Maximum Circuit Length of 11 kV AAAC Covered

Load (MW) ¹	Current (A) ²	Maximum Circuit Length (km) ²		
		49.5 sq.mm	111 sq.mm	158 sq.mm
1	62	9.1	12.3	14.9
2	123	4.5	6.1	7.4
3	185	3.0	4.1	5.0
4	247	2.3	3.1	3.7
5	309	1.8	2.5	3.0
6	370	1.5	2.0	2.5
7	432	1.3	1.8	2.1
8	494	1.1	1.5	1.9
9	556	1	1.4	-

Notes:

1. Maximum after diversity circuit demand at 85% power factor.
2. Maximum current at source of supply.
3. Calculation assumes that the load is evenly distributed along circuit and that the maximum voltage drop is 5%,.

3.2.2 Load Moments

Where design loads are spread unevenly along the line, load moments can be summed to determine whether voltage drop criteria are exceeded.

The moment of a load is the product of the load in MW and the distance of the load from the beginning of the line. For example, if a load of 50 kW is located 3 km from the beginning of the line then the moment of that load is $0.05 \times 3 = 0.15$ MW.km. Load moments can also be expressed in A.km.

The total load moment of a line is the sum of the individual load moments of all loads connected to that line.

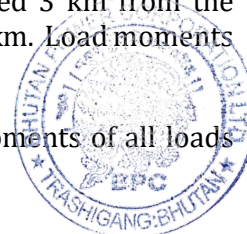


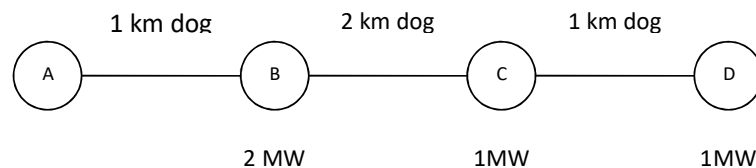
Table 24 shows the total load moment required for a 5% voltage drop for each of BPC's standard overhead conductors as specified in Table 19 and 20 for 1 MW.

Table 23: Maximum Load Moments for Standard Overhead Conductors

Conductor	Maximum Load Moments (5% Volt Drop)			
	33 kV		11 kV	
	A-km	MW-km ¹	A-km	MW-km ¹
Wolf	2,816	136.8	939	15.2
Dog	2,214	107.6	738	12.0
Rabbit	1,237	60.1	412	6.7

Note 1: Assumed power factor =0.85

Consider the simple 11 kV DOG conductor network as shown below:



The total load moment on the above feeder is computed in table 25.

Table 24: Calculation of Load Moments in Sample Feeder

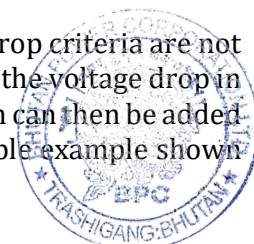
Load	MW	Distance from A (km)	Load Moment (MW.km)
B	2	1	2
C	1	3	3
D	1	4	4
Total			9

The total load moment of the feeder in the above example is less than the maximum permissible load moment for an 11 kV DOG feeder as shown in table 25. Hence the loading of the feeder shown in above figure is acceptable.

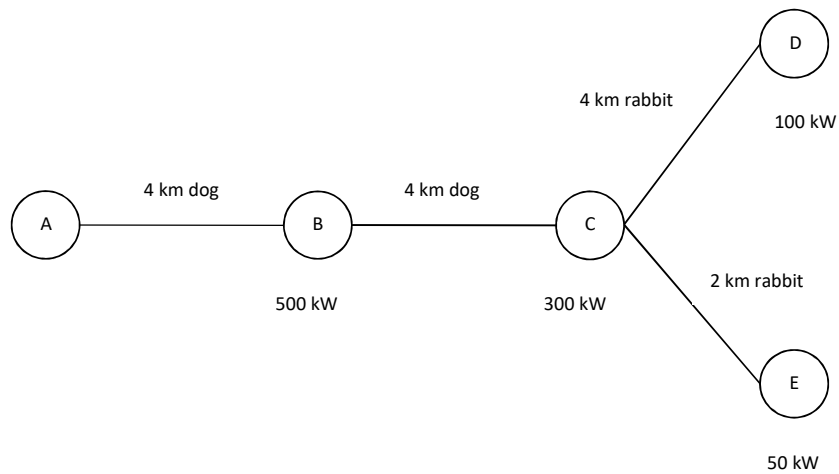
Circuits with Different Conductors

Distribution feeders in rural areas are often comprised of conductors of different sizes. Typically, heavy conductor is used close to the substation and lighter conductors are used toward the end of the feeder where currents are smaller.

It is possible to use the load moment approach to check that voltage drop criteria are not exceeded in such circumstances. However, it is necessary to calculate the voltage drop in each section of the feeder separately. The voltage drops in each section can then be added to obtain the total voltage drop along the feeder as shown in the simple example shown in figure below:



Sample 11 kV Network



Voltage drops on the sample 11 kV network are analysed in table 26 below:

Table 25: Calculation of Segment Voltage Drops

1	2	3	4	5	6 ²	7 ³
Segment	Conductor	Load (MW) ¹	Length (km)	Moment (MW.km)	Moment for (5% volt drop)	Segment volt drop (%)
A-B	Dog	0.95	4	3.8	12	1.58
B-C	Dog	0.45	4	1.8	12	0.75
C-D	Rabbit	0.1	4	0.4	6.7	0.3
C-E	Rabbit	0.05	2	0.1	6.7	0.07

Notes:

1. Includes all downstream load
2. Taken from table 25.
3. Equation is (Column 5/Column 6)x5%.

The total voltage drops at any load point can then be found by summing together the segment voltage drops, as shown in table 27.

Table 26: Calculation of Voltage Drops at Load Points

Load Point	Segments	Segment Volt Drops (%)	Total Volt Drop (%)
B	AB	1.58	1.58
C	AB, BC	1.58+0.75	2.33
D	AB, BC, CD	1.58+0.75+0.30	2.63
E	AB, BC, CE	1.58+0.75+0.07	2.47



3.2.3 Medium Voltage Underground Cables

The standard MV underground cable used by BPC for most distribution feeder applications is 3Cx150mm², aluminium conductor, XLPE insulated. Typical cable characteristics of various sizes are shown in table 70 & table 71. The cable has a direct buried current rating of 295 Amps, assuming standard installation conditions defined by the manufacturer. Since installation conditions may vary from standard, for design purposes, the current in these cables should be limited to 200 A under normal operating conditions and 250 A in a contingency operating situation.

The voltage drop in the standard 3Cx150 mm² cable is 0.488 mV/A/m. Hence the maximum length of an 11 kV underground cable circuit, where a circuit comprises two feeders connected back to back and where the load is distributed evenly over the length of the circuit is given in table 28 below.

Table 27: Medium Voltage Underground Circuit Lengths

Load (MW) ¹	Current (A) ²	Max Circuit Length (km) ³
1	62	36.5
2	123	18.3
3	185	12.2
4	247	9.1

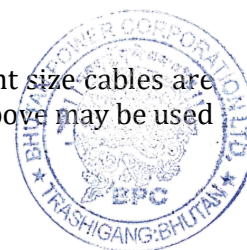
Notes:

1. Maximum after diversity circuit demand at 85% power factor.
2. Maximum current at source of supply.
3. Calculation assumes that the load is evenly distributed along circuit, and that the line voltage drop given in table 71 applies. The circuit length given is the total length between the supply busbars of two feeders interconnected in a back to back configuration.

The circuit length given in table 28 is the total length of two back to back feeders, assuming an open loop Type 1 urban distribution system design. The table has been derived assuming a worst case operating scenario, whereby the total load on both feeders is supplied from one end only. In practice, this is an unlikely situation, particularly at times of peak load. More commonly, while under contingency situations, while the load sharing will be unequal, and at least some of the load will be fed from each end. Hence, if necessary, some relaxation of the maximum circuit length criteria shown in table 28 may be appropriate.

Table 28 will also apply to the feeder backbone for the closed loop Type 2 design, where 150 mm² cable is used.

Where loads are unevenly distributed along a circuit, or where different size cables are used, the load moment approach described in sections 3.2.2 and 3.2.3 above may be used to estimate circuit voltage drops.



Situations may arise where the use of standard 150 mm² underground MV distribution cable may not be the most cost effective design. Examples include 11 kV underground feeders supplying large commercial or industrial developments. In such situations the alternative cable sizes shown in table 29 & 30 may be used. Note that the circuit lengths shown in table 29 & 30 assume a single load at the end of the circuit and are not consistent with the lengths shown in table 28, which assumes the load is evenly along the circuit route.

Table 28: Use of Different Size 33 kV Cables

Cable size	70 mm ² (Note 3)	150 mm ²	185 mm ²	300 mm ²
Current rating (A)	195	300	335	440
Load rating (MW)¹	9.5	14.6	16.3	21.4
Phase to phase voltage drop (mV/A/m)	1.01	0.50	0.42	0.29
Maximum circuit length (km) for loads shown below and a 5% voltage drop²				
2 MW	39.7	80.2	95.4	138.2
4 MW	19.8	40.1	47.7	69.1
6 MW	13.2	26.7	31.8	46.1
8 MW	9.9	20.0	23.9	34.6
10MW	7.9	16.0	19.1	27.6

Notes:

1. Assumes 85% power factor
2. Assumes a single point load at the end of the circuit.
3. 70mm² cable should not be used within 2 km of a transmission or zone substation because of its limited cable fault rating.

Table 29: Use of Different Size 11 kV Cables

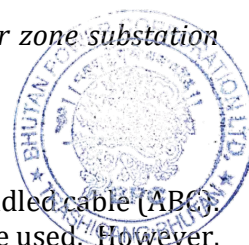
Cable size	70 mm ² (Note 3)	150 mm ²	185 mm ²	300 mm ²
Current rating (A)	200	305	340	445
Load rating (MW)¹	3.2	4.9	5.5	7.2
Phase to phase voltage drop (mV/A/m)	1.000	0.490	0.400	0.270
Maximum circuit length (km) for loads shown below and a 5% voltage drop²				
2 MW	4.5	9.1	11.1	16.5
4 MW	2.2	4.5	5.6	8.2
6 MW	1.5	3.0	3.7	5.5

Notes:

1. Assumes 85% power factor
2. Assumes a single point load at the end of the circuit.
3. 70mm² cable should not be used within 2 km of a transmission or zone substation because of its limited cable fault rating.

3.2.4 Selection of Low Voltage Conductors

BPC's standard LV overhead distribution line cable is 50 mm² aerial bundled cable (ABC). In situations where 50 mm² cable is not adequate, 95 mm² cable may be used. However,



in planning a distribution network, as far as possible, the use of long LV circuits should be avoided to prevent high losses and low voltage problems. Alternatively, installation of additional distribution transformer may be considered.

Design loads for 400 V distribution lines should take into consideration the appropriate account of the potential for future connections. As noted in Section 3.2, the maximum voltage drop on 400 V distribution lines should be limited to 4%. On this basis the maximum length of 400 V distribution circuits is given in table 30 and table 31 assuming that the load is distributed evenly along the circuit. Circuit lengths are reduced to half the length shown where the load is concentrated at the end of the circuit.

Table 30: Maximum Length of Low Voltage Overhead Distribution Circuits 50mm² ABC

Current (A) ¹	Load (kW) ²		Maximum Circuit Length (m) - 4% Voltage Drop ³	
	3 Phase	1 Phase	3 Phase ABC	1 Phase ABC
20	12	4	1,153	575
30	18	6	768	383
40	24	8	576	287
50	29	10	461	230
60	35	12	384	192
70	41	14	329	164
80	47	16	288	144
90	53	18	256	128
100	59	20	231	115
110	65	22	210	104
120	71	23	192	96
130	77	25	177	88
140	82	27	165	82
150	-	29	-	77

Notes:

1. Maximum current at source of supply.
2. Maximum after diversity circuit demand at 85% power factor.
3. Calculation assumes that the load is evenly distributed along circuit, that the maximum voltage drop is 4%, and that the line voltage drops given in table 68 applies.

Table 31: Maximum Length of LV Overhead Distribution Circuits 95 mm² ABC

Current (A) ¹	Load (kW) ²		Maximum Circuit Length (m) - 4% Voltage Drop ³	
	3 Phase	1 Phase	3 Phase ABC	1 Phase ABC
50	29	10	1,535	452
60	35	12	1,279	377
70	41	14	1,097	323
80	47	16	959	282
90	53	18	853	251

Current (A) ¹	Load (kW) ²		Maximum Circuit Length (m) - 4% Voltage Drop ³	
	3 Phase	1 Phase	3 Phase ABC	1 Phase ABC
100	59	20	768	226
110	65	22	698	205
120	71	23	640	188
130	77	25	590	174
140	82	27	548	161
150	88	29	512	151
160	94	31	480	141
170	100	33	452	133
180	106	35	426	126
190	112	37	404	119
200	118	39	384	113
210	124	41	366	108
220	-	43	-	103

Notes:

1. Maximum current at source of supply.
2. Maximum after diversity circuit demand at 85% power factor.
3. Calculation assumes that the load is evenly distributed along circuit, that the maximum voltage drop is 4%, and that the line voltage drops given in table 68 applies.

Where loads are unevenly distributed along a line the load moment approach described in Sections 3.2.2 can be used. The maximum allowable load moments are given in table 32 below.

Table 32: Maximum Load Moments of Low Voltage Overhead Distribution Circuits

	Maximum Load Moments (4% Voltage Drop)			
	50 mm ² ABC Cable		95mm ² ABC Cable	
	A.m	kW.m ¹	A.m	kW.m ¹
Three Phase	11,527	6,788	38,379	22,601
Single Phase	5,745	1,123	11,297	2,209

Note: Assumes 85% power factor.

3.2.5 Overhead Service Lines

The overhead service lines are generally used where the LV distribution lines are overhead. However, in some cases, the underground cable maybe used although distribution lines are overhead.

The service connection from a LV ABC overhead line shall use a hard drawn copper service cable and connected to the LV ABC line through the use of Insulation Piercing Connector (IPC) per phase without which no service connection will be done. The maximum voltage drop on an overhead service line should be limited to 2%. The service line cable size necessary to meet this criterion depends on both the maximum consumer

load and the service line length and should be selected from table 33,34,35(a) and table 35(b).

Table 33: Selection Guide for Single Phase Overhead Copper Service Line Cables

Load (A)	Maximum Service Line Length (m) for Different Cable Sizes			
	4 mm ²	6 mm ²	10 mm ²	16 mm ²
10	41	61	103	164
20	20	31	52	82
30	14	20	34	55
40	10	15	26	41
50		12	21	33
60			17	27

Table 34 : Selection Guide for Single Phase Overhead Aluminium Service Cables

Load (A)	Maximum Service Line Length (m) for different cable sizes				
	6 mm ²	10 mm ²	16 mm ²	25 mm ²	35 mm ²
10	58	91	147	231	401
20	29	46	73	116	201
30		30	49	77	134
40			37	58	100
50				46	80
60					67

Table 35 (a): Selection Guide for Three Phase Overhead copper Service Line Cables

Load (A)	Maximum Service Line Length (m) for Different Cable Sizes			
	6 mm ²	16 mm ²	35mm ²	50mm ²
10	123	329	718	967
20	62	165	359	483
30	41	110	239	322
40	31	82	179	242
50		66	144	193
60		55	120	161
70		47	103	138
80		41	90	121
90			80	107
100			72	97
110			65	88
120			60	81
130			55	74

140				69
150				64
160				60

Table 35 (b): Selection Guide for three Phase Overhead Aluminium Service Cables

Load (A)	Maximum Service Line Length (m) for different cable sizes								
	06 mm²	10 mm²	16 mm²	25 mm²	35 mm²	50 mm²	70 mm²	95 mm²	120 mm²
10	91	147	231	401	500	702	1087	1355	1790
20	46	73	116	201	250	351	544	677	895
30		49	77	134	167	234	362	452	597
40			58	100	125	176	272	339	447
50				80	100	140	217	271	358
60				67	83	117	181	226	298
70					71	100	155	194	256
80						88	136	169	224
90						78	121	151	199
100							109	135	179
110							99	123	163
120							91	113	149
130								104	138
140								97	128
150									119
160									112

In line with BPC supply rule, the maximum length of service connection (service cable) shall not exceed 70 meters. However, in exceptional cases, when it exceeds 70 m, base on load and its conductor size, the above circuit length can be followed.

3.2.6 Underground Low Voltage Distribution Cables

The design of underground low voltage distribution systems will generally be constrained by the maximum allowed voltage of 4%. Given the diversity of loads in urban situations, the arrangement of low voltage distribution will need to be designed on a case by case basis. Appropriate provision should be made for future load growth, due to both load increases in existing installations and the potential for new installations which will have to be catered from the network. In determining the maximum design load on a distribution system a planning horizon of between 5 to 10 years is appropriate.

LV distribution networks may be designed using the load-moment method described in Sections 3.2.2 above. Relevant design data for BPC's standard cable sizes is given in table 36 below.



Table 36: Design Data for Underground Low Voltage Distribution Cables

Cable Size (mm ²)	Max Current (A)	Max Load (kW) ¹	Length for 4% Volt Drop ² (m)	Max Load Moment (A.m)	Max Load Moment (kW.m)
1x630	390	270	245	95,465	66,140
1x400	325	225	231	75,037	51,987
4x400	335	232	224	75,126	52,049
4x300	305	211	209	63,771	44,182
4x150	210	145	167	35,025	24,266
4x70	135	94	125	16,874	11,691

Notes:

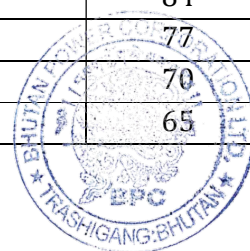
1. 85% power factor assumed.
2. Calculation assumes that load is distributed evenly along the cable. If the load is at the end of the cable then the maximum length is one half the length shown.

3.2.7 Underground Service Line Cables

Underground service lines should be designed for a maximum voltage drop of 2%. The cable size necessary to meet this criterion depends on both the maximum consumer load and the service line length and should be selected from table 37. It should be noted that in the case of service lines, the load is concentrated at the end of the cable and the allowed length is less than it would be if the load was distributed across the length of the circuit.

Table 37: Selection Guide for Underground Aluminium Service Line Cables

Load (A)	Maximum Length (m) for Different Cable Sizes					
	Single Phase			Three Phase		
	6mm ²	16mm ²	35mm ²	16mm ²	35mm ²	70mm ²
10	37	99	216	198	434	844
20	18	49	108	99	217	422
30	12	33	72	66	145	281
40	9	25	54	50	109	211
50		20	43	40	87	169
60		16	36	33	72	141
70				28	62	121
80					54	105
90					48	94
100						84
110						77
120						70
130						65



3.3 General Earthing Arrangement

In the design and construction of the power system it is important to ensure that the network is properly earthed. The earthing system is designed to perform two main functions:

- It ensures that, in the event of equipment fault where there is a low resistance path to earth or to a metallic enclosure of an apparatus; sufficient fault current will flow to ensure the operation of automatic protection system. If the protection does not operate, the potential of the metallic enclosure can rise to the extent that it can be hazardous to a person coming in contact with it.
- If metallic enclosures are bonded to a common earthing point the potential of the enclosures should be the same and the hazard to a person who is in contact with two or more metal objects is reduced.

In order to perform this function correctly, the resistance of any connections to earth should always be as low as possible. The IEEE 80 have recommended a maximum ground resistance value of 5.0 ohms for distribution substation.

In areas where it is difficult to obtain low earth resistance; the use of low earth resistance backfill foreign materials or additional earthing electrodes may be considered. Different type of earthing installations is also mentioned in “Distribution System Earthing Guidelines” of BPC (2018)

Earthing arrangements on the Bhutan network are as follows:

- LV system neutrals shall be connected to earth at the distribution substation through a pipe earth system and at each consumer installation through a stake earth.
- All steel poles with bare/partially insulate overhead conductor, except LV poles, should be earthed through a stake earth system. Since LV lines are ABC, therefore LV poles need not be earthed. It is important that earth electrodes are correctly installed and, in particular, that all neutral and earth connections use the correct lugs and are properly made. The wrapping of earth conductors around earth connections without using the correct lugs or bolts does not ensure a good connection and may create a potential electrical hazard.

3.4 Overhead Line Design

3.4.1 Medium Voltage Lines

Two types of poles are being used in BPC; Steel swaged and galvanised telescopic pole. These standard poles are shown in table 45 & table 46 respectively and it is used for both 11&33 kV voltage, irrespective of the conductor. Galvanised Telescopic poles are used for longer spans with and without shielding wire.



The required pole strength for various average spans and conductor sizes, calculated using the methodology given in IS 2713 for steel swaged pole, is shown in table 38.

Table 38: Required Steel Swaged Pole Strength for MV Overhead Lines (ACSR)

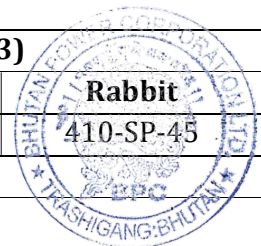
	11 & 33 kV		
Pole Length (m)	10		
Standard Pole Type	410-SP-45		
Std Pole Strength (kN)	2.02		
Average Span (m)	Single Pole Load (kN)		
	Wolf	Dog	Rabbit
50	1.54	1.45	1.36
60	1.62	1.52	1.41
70	1.71	1.58	1.45
80	1.79	1.65	1.5
90	1.87	1.71	1.54
100	1.95	1.77	1.59
120	-	1.90	1.68
150	-	-	1.82

Table 39: Required Steel Swaged Pole Strength for MV Overhead Lines (AAAC Covered)

	11 & 33 kV		
Pole Length (m)	10		
Standard Pole Type	410-SP-45		
Std Pole Strength (kN)	2.02		
Average Span (m)	Single Pole Load (kN)		
	158	111	49.5
50	1.61	1.55	1.45
60	1.71	1.63	1.51
70	1.81	1.72	1.58
80	1.90	1.8	1.64
90	2.00	1.89	1.7
100	-	1.97	1.77
120	-	-	1.89
130	-	-	1.96

Table 40: Steel Swaged Poles for Overhead Distribution Lines

	Pole Type (IS 2713)		
	Wolf	Dog	Rabbit
33 kV (10m pole)	410-SP-45	410-SP-45	410-SP-45
LV ABC (7.5 m pole)	410-SP-9		



33 kV&11 kV (12m pole)	410-SP-62
-----------------------------------	------------------

Based on the site situation, 12m pole may be used particularly when the required standards cannot be achieved by normal poles, such as; construction of 11&33 kV double circuit pole with horizontal/vertical arrangement and also for lines crossing roads. Double circuit arrangement is shown in drawing no. BPC-DDCS-2023- 12 and 13.

Standard structure BPC designs for 33 kV and 11 kV overhead lines are suitable only for short spans due to the limited phase spacing. Longer spans require wider phase spacing as shown in table 41 to minimise the risk of conductors clashing in mid span. In such situations support structures should be specifically designed for each site.

Table 41: Maximum Span Lengths for Different Phase Spacing

Phase (m)	Spacing	Maximum Span Length (m)		
		33 kV		11 kV
		Design Tension 5% MBL	Design Tension 17% MBL	Design Tension: 17% MBL
1.5		90	130	150
1.8		120	180	200
2.1		150	240	260

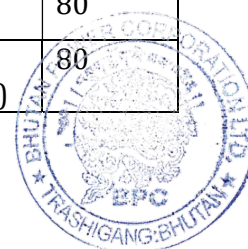
BPC's standard practice is to string 33 kV lines to a design tension of 5% conductor minimum breaking load (MBL) and to string 11 kV lines to a design tension of about 17% conductor (MBL). This is consistent with the sag-span tables given in table 89 to table 99. The 17% MBL design tension is consistent with generally accepted practice for distribution lines.

It can be seen from table 41 that the maximum span for a given phase spacing can be significantly increased by increasing the conductor design tension. Conductor tensions on 33 kV lines can be increased to the 11 kV design level for longer spans if the pole structures at each end of the line are guyed along the length of the line. Generally, with the phase spacing of 1.5 m, the maximum span length of 50 to 60 meters is adequate for both 33 kV and 11 kV systems.

The design of 11.2m and 12m Telescopic poles are aim to withstand the working load as given in table 42.

Table 42: Telescopic Galvanized Pole for Overhead Distribution Lines

Total Length (meter)	Horizontal Design working load (kgf)	Vertical Design working load (kgf)	No. of Sections	Length of Each Section(meter)	Span (meter)
11.2	286	435	5	2.65	80
12	286	500	6	1.08 (top sec.) 2.65 (rest sec.)	80



3.4.2 Low Voltage ABC Lines

In designing LV overhead circuits, the following approach should be used.

- Determine the size of cable required based on the forecast load/current and voltage drop. Ratings of the standard ABC cables are given in table 68. Should this analysis indicate that 95 mm² cable is required, consider whether a distribution line extension and a new distribution substation would be a preferred alternative as this will generally reduce losses and provide better voltage regulation to customers located at the far end of the line.
- Locate the poles to ensure the required ground clearance is achieved and the loading of the pole is not exceeded.
- The required ground clearance is 5.5 m across a street and 4.6 m elsewhere;
- Design data for overhead lines using ABC cables is given in table 43 and table 44.
- From table 43 and table 44, note that for ABC cables the sag-span data is independent of the size of the cables or the number of cores.
- The installation arrangement for LV poles with fittings are shown in drawing no. BPC-DDCS-2023-14.
- Use a guy at poles where the line angle exceeds 5° to support the conductor transverse load. Guy insulators are not required on low voltage ABC lines.

Table 43: Design Data for Low Voltage Overhead Lines 50 mm² ABC.

Pole Type (IS 2713)		410-SP-9	
Pole Length (m)		7.5	
Maximum Sag – Across Street		0.4	
Maximum Sag – Elsewhere		1.4	
Std Pole Strength (kN)		1.81	
Span (m)	Sag (m)	Pole Load (kN) ¹	
		4c ABC	2c ABC
30	0.15	1.08	1.02
40	0.26	1.21	1.12
50	0.41	1.34	1.23
60	0.59	1.47	1.34
70	0.80	1.60	1.45
80	1.04	1.73	1.55
90	1.32	-	1.66

Table 44: Design Data for Low Voltage Overhead Lines 95 mm² ABC.

Pole Type (IS 2173)		410-SP-9	
Pole Length (m)		7.5	
Maximum Sag – Across Street		0.4	
Maximum Sag – Elsewhere		1.4	
Std Pole Strength (kN)		1.81	
Span (m)	Sag (m)	Pole Load (kN)	
		4c ABC	2c ABC
30	0.15	1.21	1.12
40	0.26	1.39	1.27
50	0.41	1.56	1.41
60	0.59	1.73	1.56
70	0.80	-	1.70

Note: In calculating pole load the average of the two spans on each side of the pole should be used.



4. STANDARDISATION OF DISTRIBUTION EQUIPMENT

4.1 Introduction

Standardisation of electrical equipment helps in reducing the range of accessories and spare parts to be carried for construction and maintenance purposes. Therefore only equipment of the capacities and specifications described in this chapter should be used on the BPC system.

4.2 Poles

There are two types of electric poles used in BPC; Steel swaged Poles and Galvanized Telescopic poles.

4.2.1 Steel Swaged Poles

Steel poles shall be swaged, mild steel poles manufactured in accordance with the requirements of IS 2713 and fabricated in three parts for assembly at site. The poles shall be hot dip galvanised internally and externally up to the level, which goes inside the earth. Data on standard poles used by BPC is given in table Table 45 and drawing no. BPC-DDCS-2023-15

Table 45: Standard Steel Swaged Poles used by BPC

Height	Strength	Size as per (IS 2713)	Normal Service
7.5 m	1.81 kN	410-SP-9	LV ABC
10 m	2.02 kN	410-SP-45	11 kV & 33 kV
12 m	2.27 kN	410-SP-62	Special case ¹

Note 1: For special cases such as shielding wire/road & river crossing, 12m pole shall be designed based on specific site conditions.

The 7.5 m LV pole shall be provided with 18 mm dia. through holes at 150 mm, 350 mm, 550 mm and 750 mm from the pole top at 90° cross-angles for fixing the LV cable. Earthing of LV pole is not required as the overhead conductor is insulated.

4.2.2 Galvanised Telescopic Pole

The standard overall length of telescopic poles used in BPC shall be of 11.2 m and 12 m which come in 5 and 6 sections respectively. All 5 sections of 11.2 m and 12m pole shall be same in design from the bottom, except the top section of the 12 m pole. This has been designed to offer interchangeability during construction phase as the top section of 12 m pole can be easily capped on 11.2 m pole. The side taper for the pole is recommended between 10-25 mm per meter length which shall be uniform for all the sections. Length of pole sections shall be at a minimum lap of 1.5 times with the largest inside diameter of the female section with allowances for fabrication tolerance. Each section of the pole shall have one longitudinal weld except for the bottom section which can have a maximum of one additional longitudinal weld. The 12 m poles shall be equipped with 18 mm diameter

through holes (for through bolt size M16) at 100 mm from pole top for fixing suspension clamp for shielding wire. The holes shall be at right angles to the run of the direction of the conductors. The distance of footing bar shall be 300 mm.

Table 46: Standard Galvanised Telescopic Poles used by BPC

Total Length	Design working load	No of sections	Remarks
12.0 m	2.8 kN	6	33 & 11 kV with shield wire
11.2 m	2.8 kN	5	33 & 11 kV without shield wire

Details of the telescopic pole are given in table 47 and also on drawing no. BPC-DDCS-2023-19

Table 47: Details of 11.2 meter and 12 meter Galvanised Telescopic pole

Sl#	Description of parameters	Unit	Telescopic pole	
1	Overall Length of Poles	m	12	11.2
2	Embedded Length	m	2.0	1.87
3	Number of Sections	nos	6	5
4	Length of Sections (of whole sections)			
	-Section-I	m	1.08	2.65
	-Section-II	m	2.65	2.65
	-Section-III	m	2.65	2.65
	-Section-IV	m	2.65	2.65
	-Section-V	m	2.65	2.65
	-Section-VI		2.65	-
5	Outside Diameter (Top & Bottom)			
	Section-I (Top)/(Bottom)	mm	100/132	119/197
	Section-II (Top)/(Bottom)	mm	119/197	180/258
	Section-III (Top)/(Bottom)	mm	180/258	240/318
	Section-IV (Top)/(Bottom)	mm	240/318	298/375
	Section-V (Top)/(Bottom)	mm	298/375	352/430
	Section-VI (Top)/(Bottom)		352/430	-
6	Thickness of Steel			
	-Section-I	mm	2.1	2.1
	-Section-II	mm	2.1	2.1
	-Section-III	mm	2.1	2.1
	-Section-IV	mm	2.1	2.1
	-Section-V	mm	2.1	2.1
	-Section-VI	mm	2.1	
7	Design Working Load (Horizontal)	kgf	286	286
8	Design Working Load (Vertical)	kgf	500	435

Sl#	Description of parameters	Unit	Telescopic pole	
9	Weight of pole (of all sections including wt of Zinc coating)	kg	207.333	200.495
	-Section-I	kg	6.477	21.678
	-Section-II	kg	21.678	30.054
	-Section-III	kg	30.054	38.309
	-Section-IV	kg	38.309	46.162
	-Section-V	kg	46.162	53.695
	-Section-VI	kg	53.695	
10	Size of base plate (Lx B x Thickness)	mm	500x500x3	500x500x3
11	Weight of Baseplate	kg	9.782	9.782

4.2.3 Base Plate, Pole Cap and Pole Earthing

Steel swaged poles shall be supplied complete with pole cap and base plate. The pole cap shall be welded to the pole top and shall be curved at the top to allow water to run down whereas the base plate shall be as per the dimensions indicated in the relevant drawings. All HT steel poles shall have provision for earth points above the ground line after installation. This shall be a through bolt of 12 mm diameter located at a height of 350 mm above the ground line. The ground line position shall be approximately 1/6 of the total pole length.

Telescopic pole shall be provided with galvanized pole cap and base plate. The pole cap for 11.2 m pole or 12 m pole shall not be welded on poles. The pole caps shall be designed and manufactured to fit on the pole top respectively. Base plates shall be galvanized steel with minimum thickness of 3 mm. The base plate shall be made circular and provided with proper fixing arrangements for easy installation at site.

Each telescopic pole shall be provided with an earthing lug welded on the pole for pole earthing. This shall be with 14 mm dia hole with bolt and nut arrangement at 350 mm above ground level to connect to spike earthing.

4.2.4 Foot Bars and Installation Lugs

Telescopic poles shall be designed to enable installing removable foot-bars. Installation lugs for mounting the foot-bars shall be welded on the pole surface. Four (4) galvanized removable foot bars shall be supplied for each pole which shall be kept permanently on the pole above the anti-climbing device. Details are given on drawing no. BPC-DDCS-2023-16/3-5.

4.2.5 Anti-climbing Device

In order to prevent unauthorized person from climbing any of the supports of HT lines and substations, anti-climbing devices are provided to each poles. Anti-climbing device shall be a clamp with protruding spikes installed at a height of 3.5 m ~ 4 m above the



ground level for lines and below 3 m for substations. Details are shown in drawing no. BPC-DDCS-2023-16/4-5.

4.2.6 Danger Plate

Danger plates in English and Dzongkha is to be provided which can be fixed on the structure using binding wire. The danger plate size shall be 250x200 mm.

The plate shall be made from mild steel, at least 1.6 mm thick and vitreous enamelled white with letters, figures and the conventional skull and cross-bones in red color on the front side. The rear side of the plate shall also be enamelled. The dimensions of the letters, figures and their respective positions shall be as per the drawing no. BPC-DDCS-2023-17. Danger plate shall be installed at a visible location at a minimum height of 2 meters above ground level.

4.3 Clamps

The clamps shall be designed and manufactured to properly fit the channels on poles at the expected height. The internal diameter of semi circle ring part in clamp shall be designed to suit the outer diameter of poles at the expected height. The clamps shall be adjustable to be used for some range of pole diameters so that such universal design will reduce the number of clamp sizes. The size of bolt and nut for pole clamps shall be equal or more than M16.

4.3.1 Clamps for Galvanised Telescopic Pole

The recommended clamp for telescopic pole is categorized into three types as stipulated below. All materials shall be galvanized. Details are given on drawing no. BPC-DDCS-2023-16/5-5.

- **Full Clamp**

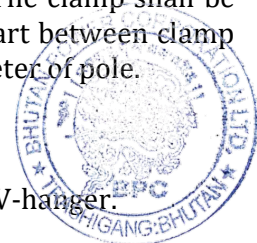
This clamp shall be designed to suit for mounting two steel channels on the double pole structures such as cross arm assemblies for lines and substations. This clamp consists of two sets of bolt and nut (comprised of a full threaded bolt, a flat washer, a spring washer and a nut) provided to support the cross-arms. Welding of bolts on the clamps shall not be allowed. These bolts-heads shall not bulge on the internal surface of the ring after assembly. Another two sets of bolt and nut (comprised of a full thread bolt, a nut, a spring washers and two flat washers) shall be provided for coupling the half-round rings.

- **Half Clamp**

A semicircle clamps shall be designed for mounting one steel channel/angle on the single or double pole structures. This clamp will consist of two sets of bolt and nut (comprised of a full thread bolt, a nut, a spring washers and two flat washers). The clamp shall be designed to fit the single channel on poles and the space of bolting part between clamp and channel may be designed at approximately 1/4 of the outer diameter of pole.

Stay Clamp Assembly

Stay clamp assembly for telescopic pole consist of stay clamp and the V-hanger.



4.3.2 Clamps for Steel Swaged Pole

- “M” clamp is used for supporting two channels on double pole structures such as cross arms and transformer platforms.
- “U+M” clamp is used for supporting single crossarm channel on single pole structure. It is a combination of “U” clamp and “M” clamp.
- “Full clamp” is used for supporting intermediate supports for cross bracing, ABS handle support and equipment supports.
- Stay clamp consist of two “U” clamps.

The detail of clamps used for steel swaged pole is given in drawing no. BPC-DDCS-2023-15/7-7.

4.4 Line Cross-arm Assemblies for Steel Swaged Pole

4.4.1 Single Pole Assemblies

Single pole structure is used for small angle or tangent lines. Single pole assembly shall consist of following items:

Table 48: Pole fittings for Single Pole Assemblies

	Items	Quantity
A	SP Top Hamper Assembly	
i	ISMC 100X50, welded in L-shape	1 No.
ii	“U+M” clamp with GI nuts and bolts, 16 mm dia, 125 mm long, complete with one flat washer and one spring washer.	1 Set
B	SP Cross Arm Assembly	
i	ISMC 100X50, 1620 mm length complete with necessary hole	1 No.
ii	“U+M” clamp with GI nuts and bolts, 16 mm dia, 125 mm long, complete with one flat washer and one spring washer.	1 Set

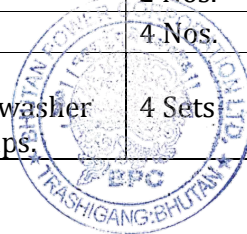
Details are given on drawing no. BPC-DDCS-2023-18/1-11.

4.4.2 Double Pole Assemblies

Double pole will be used for a large angle lines or at the dead end point on MV distribution lines.

Table 49: Pole fittings for Double Pole Assemblies

	Items	Quantity
1	DP Top Cross arm Assembly (10 m)	
i	ISMC 100X50, 3150 mm length complete with necessary holes	2 Nos.
ii	“M” clamp	4 Nos.
iii	Sets of GI nuts and bolts, 16 mm dia, 175 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for the clamps.	4 Sets



iv	MS flat string bracing, 50x6 mm, 227 mm length complete with necessary holes for fixing insulator	6 Nos.
v	Sets of GI nuts and bolts, 16 mm dia, 150 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for bolting MS flat and disc insulator.	6 Sets
2	DP Cross Bracing Assembly (10 m)	
i	MS angle 50x50x6 mm, 2030 mm length complete with necessary holes	1 No.
ii	MS angle 50x50x6 mm, 2000 mm length complete with necessary holes	1 No.
iii	MS angle 50x50x6 mm, 2919 mm length complete with necessary holes	2 Nos.
iv	Full clamp (pole dia 114.3 mm outer dia)	2 Nos.
v	Full clamp (pole dia 165.1 mm outer dia)	2 Nos.
vi	Sets of GI nuts and bolts, 16 mm dia, 100 mm long, complete with one flat washer and one spring washer.	8 Sets
vii	Sets of GI nuts and bolts, 16mm dia, 35mm long, complete with one flat washer and one spring washer.	5 Sets

Details are given on drawing no. BPC-DDCS-2023-18/2-11

4.5 Line Cross-arm Assemblies for Telescopic Pole (11.2 meter)

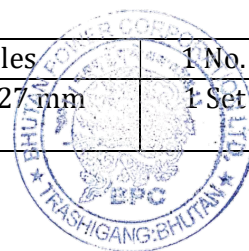
Pole fittings for telescopic pole shall be galvanised and there is no need of painting and concreting at site.

4.5.1 Single Pole Assemblies

Table 50: Pole fittings for Single Pole Assemblies

	Items	Quantity
A	SP Top Cross arm Assembly (11.2 m)	
i	ISMC 100X50, 300 mm length complete with necessary holes	1 No.
ii	Set of half clamp with GI nuts and bolts, 16 mm dia, 105 mm long, complete with one flat washer and one spring washer	1 Set
B	SP Lower Cross Arm Assembly (11.2 m)	
i	ISMC 100X50, 1620 mm length complete with necessary holes	1 No.
ii	A set of half clamp with GI nuts and bolts, 16 mm dia, and 127 mm long, complete with one flat washer and one spring washer	1 Set

Details are given on drawing no. BPC-DDCS-2023-19/1-21



4.5.2 Double Pole Assemblies

Table 51: Pole fittings for Double Pole Assemblies

	Items	Quantity
1	DP Top Cross arm Assembly (11.2 m)	
i	ISMC 100X50, 3650 mm length complete with necessary holes	2 Nos.
ii	Sets of full clamp	2 Sets
iii	Sets of GI nuts and bolts, 16 mm dia, 175 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for the clamps.	4 Sets
iv	MS flat string bracing, 50x6 mm, 268 mm length complete with necessary holes for fixing insulator	6 Nos.
v	Sets of GI nuts and bolts, 16 mm dia, 150 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for bolting MS flat and disc insulator.	6 Sets
2	DP Cross Bracing Assembly (11.2 m)	
i	MS angle 65x65x6 mm, 2346 mm length complete with necessary holes	1 No.
ii	MS angle 65x65x6 mm, 2400 mm length complete with necessary holes	1 No.
iii	MS angle 65x65x6 mm, 2746 mm length complete with necessary holes	2 Nos.
iv	Half clamp to suit different section of the pole with 8 sets of GI nuts and bolts, 16mm dia, complete with one flat washer and one spring washer.	4 Nos.
v	Sets of GI nuts and bolts, 16 mm dia, 35 mm long, complete with one flat washer and one spring washer	5 sets

Details are given on drawing no. BPC-DDCS-2023-19/3-21

4.6 Line Cross-arm Assemblies for Telescopic Pole (12 meter)

12 meter telescopic poles is used with shielding wire and the arrangement of the shielding wire for the single pole assembly will be hanged by U-Bolt on the top side of pole. A "U" bracket with M16 hook bolt and nut shall be provided under hardware fittings. The top segment of 12m pole shall have holes for a through bolt (M16) for the suspension clamp. For double pole structure, the shield wire will be stringed on the top cross-arm by a preformed assembly comprising of a preformed dead-end termination, an eye-thimble and a cross arm strip.

4.6.1 Single Pole Assemblies

Table 52: Pole fittings for Single Pole Assemblies

	Items	Quantity
A	SP Shielding Arrangement	
i	200 mm long, 16 mm dia bolts threaded at both ends.	1 No.
ii	U-type connector of 75x50x6mm with 12mm dia and 17.5 mm dia holes	1 Set
	L-bolt of 10 mm dia, 35 mm long threaded.	1 Set

B	SP Top Crossarm Assembly (12 m)	
i	ISMC 100X50, 1000 m long	1 No.
ii	Set of half clamp with GI nuts and bolts, 16 mm dia, complete with one flat washer and one spring washer.	1 Set
iii	Bracing angle ISA 40x40x5, 892 mm long with full clamping arrangement with necessary nuts and bolts.	1 No.
C	SP Lower Cross Arm Assembly (12 m)	
i	ISMC 100X50, 1650 mm length complete with necessary holes	1 No.
ii	Set of half clamp with GI nuts and bolts, 16 mm dia, complete with one flat washer and one spring washer	1 Set

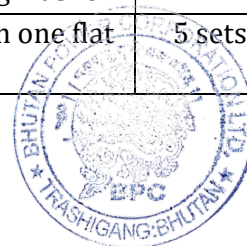
Details are given on drawing no. BPC-DDCS-2023-19/5-21

4.6.2 Double Pole Assemblies

Table 53: Pole fittings for Double Pole Assemblies

	Items	Quantity
A	DP Shielding arrangement	
i	ISMC 75x40x2283 mm long	1 No.
ii	Sets of half clamp with GI nuts and bolts, 16 mm dia, complete with one flat washer and one spring washer.	2 Sets
iii	Sets of crossarm strap with thimble socket	2 Sets
iv	Shielding wire preform	2 Nos.
B	DP Top Cross arm Assembly (12 m)	
i	ISMC 100X50, 3650 mm length complete with necessary holes	2 Nos.
ii	Sets of full clamp	2 Sets
iii	Sets of GI nuts and bolts, 16 mm dia, 175mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for the clamps.	4 Sets
iv	MS flat string bracing, 50x6 mm, 268 mm length complete with necessary holes for fixing insulator	6 Nos.
v	Sets of GI nuts and bolts, 16 mm dia, 150 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for bolting MS flat and disc insulator.	6 sets
C	DP Cross Bracing Assembly (12 m)	
i	MS angle 65x65x6 mm, 2346 mm length complete with necessary holes	1 No.
ii	MS angle 65x65x6 mm, 2400 mm length complete with necessary holes	1 No.
iii	MS angle 65x65x6 mm, 2746 mm length complete with necessary holes	2 Nos.
iv	Half clamp to suit different section of the pole with 8 sets of GI nuts and bolts, 16 mm dia, complete with one flat washer and one spring washer.	4 Nos.
v	Sets of GI nuts and bolts, 16 mm dia, 35mm long, complete with one flat washer and one spring washer	5 sets

Details are given on drawing no. BPC-DDCS-2023-19/8-21



4.7 Substation Structure Assemblies

Substation structure will be used for mounting the transformer, lightning arresters, drop out fuse and transformer Distribution Board. There shall be proper interface between transformer base channel and the mounting platform on the pole.

All the complete set of assembly, including cross-arms, transformer platforms, clamps for cross-arms, tension straps, stay clamps, bolts, nuts and washers, etc. shall be designed as shown on relevant drawings. Following are the details of fittings for IS poles and similar fittings are also used for telescopic poles as shown in the drawings.

Table 54: Pole fittings for Substation Structure Assemblies

	Items	Quantity
A	Substation Pole Top Cross Arm Assembly	
i	ISMC 100X50, 3110 mm length complete with necessary holes	2 Nos.
ii	“M” clamp	4 Nos.
iii	Sets of GI nuts and bolts, 16 mm dia, 175 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for clamp.	4 Sets
iv	Sets of MS flat string bracing, 50x6 mm, 227 mm length complete with necessary holes.	6 Sets
v	Sets of GI nuts and bolts, 16 mm dia, 150 mm long, complete with one flat washer and one spring washer along with 20mm dia GI pipe for bolting MS flat and disc insulator.	6 Sets
B	Substation Equipment Mounting Assembly	
i	ISMC 75X40, 3110 mm length complete with necessary holes	3 Nos.
ii	“U+M” clamp	6 Nos.
iii	Sets of GI nuts and bolts, 16 mm dia, 125 mm long, complete with one flat washer and one spring washer.	12 Sets
C	Transformer Platform Assembly	
i	ISMC 125X65, 3110 mm length complete with necessary holes	2 Nos.
ii	“M” clamp	4 Nos.
iii	Sets of GI nuts and bolts, 16 mm dia, 240 mm long, complete with one flat washer and one spring washer.	4 Sets

Details are given on drawing no. BPC-DDCS-2023-18 & BPC-DDCS-2023/19

4.8 Load Break Switch/Air Break Switch Assemblies

LBS/ABS is mounted on double-pole structure in vertical configuration. Assembly includes items shown in drawing no. BPC-DDCS-2023-18/8-11& 18/9-11& BPC-DDCS-2023-19/18-21, 19/19-21,19/20-21, 19/21-21

4.9 Auto Recloser Assemblies

The Auto recloser (AR) is either mounted on double or single pole structures. For double pole mounting, the mounting platform will be similar to that of transformers. Auto



recloser tank and the PT tank shall be provided with base channels similar to transformers with anchor bolts and nuts to fit on the mounting platform. Typical ARCB installation is shown on drawing no. BPC-DDCS-2023-18/10-11 & 20/11-11

4.10 Insulators

Both Pin & disc insulators shall conform to IS: 731. Depending on the materials, two types of insulators are used; Porcelain and Polymer Insulator.

4.10.1 Pin Insulators

Table 55: Minimum Specification for Porcelain Pin Insulators

Characteristics	Unit	11 kV	33 kV		
Applicable Standard	IEC 60383-1 and IS 731				
Insulator Test Voltage					
Highest System Voltage	kV(RMS)	12	36		
Visible Discharge Test	kV(RMS)	9	27		
Wet-Power frequency withstand	kV(RMS)	35	75		
Minimum power frequency flashover voltage	kV	110	140		
Dry				70	95
Wet					
Power frequency puncture withstand test	kV	105	180		
Impulse voltage withstand test	kV peak	75	170		
Dimensions of insulator					
Nominal diameter	mm	229	305		
Nominal height	mm	165	241		
Nominal creepage distance	mm	25mm/kV	25mm/kV		
Approximate weight	kg	4.5	11		
Dimensions of pin heads					
Applicable standard	IS 2486 (Part II)				
Minimum Failing load in kN	kN	5	10		
Stalk length	mm	165	300		
Type		Small head	Large head		
Shank length	mm	150	150		
Shank dia	mm	24	24		
Threads on the shank	mm	Not less than 100 mm	Not less than 100 mm		

Details are given on drawing no. BPC-DDCS-2023-20



Table 56: Minimum Characteristics of Polymer Pin Insulators

Characteristics	Unit	11 kV	33 kV
Applicable Standard		IEC 61109,IEC 60815-3 & IS 13134	
Type of insulators		Composite	
Material of the insulator		Silicon rubber	
Material of the core rod		ECR grade Boron free	
Material of the housing & weather sheds		Silicon Rubber	
Material of the end fittings		Spheroidal graphite cast Iron (SGCI) with hot dip galvanised	
Sealing compound of the end fitting		Silicon based sealant	
Type of sheds		Aerodynamic with alternating sheds	
Diameter of FRP rod	mm	24	
Insulator Test Voltage			
Highest System Voltage	kV(RMS)	12	36
Visible Discharge Test	kV(RMS)	9	27
Wet-Power frequency withstand	kV(RMS)	35	75
Power frequency puncture withstand test	kV	105	180
Impulse voltage withstand test	kV peak	75	170
Nominal creepage distance	mm	25mm/kV	25mm/kV
Mechanical Load			
Cantilever strength (Minimum failing load)	kN	5	10
Color	-	Grey	

4.10.2 Fittings for Pin Insulators

The top part of the porcelain & polymer insulators shall have necks and grooves suitable for fastening conductors with tie wire or preformed fitting. The insulators shall be suitable for using any of the covered conductors of sizes up to 150 sq.mm with 3mm thickness of XLPE insulation and ACSR conductor sizes up to 150 mm². Insulators should thus be manufactured accordingly to fit with the above ranges of conductor sizes.

The pin of the porcelain insulator shall be supplied complete with a hot dip galvanised forged steel pin, complete with nut, lock nut and spring washer. The ultimate mechanical strength of the pin insulator assembly shall be equal or more than the above requirement of cantilever strength. The pin shall be fitted on the cross-arms, drilled with holes of 26 mm diameter. The pin shall be provided with bolt in length of 150 mm with 100 mm thread as per IS 2486 (II).

The other end of the polymer Insulators shall be of same size with porcelain pin type. (to offer interchangeability between the two insulators). The dimension of the end fitting of polymer pin insulator is given in the table below:



Table 57: Details of Pin-End Fittings for Fixing on the Channel

Sl	Item	Length of end fittings to be fixed	Min. threaded portion of end fittings	Dia of rod
1	33 kV	150 mm	100 mm	24 mm
2	11 kV	150 mm	100 mm	24 mm

Details are given on drawing no. BPC-DDCS-2023-20/3-7

4.10.3 Disc Insulator

Table 58: Minimum Characteristics applied to Porcelain Disc Insulators

Characteristics	Unit	11 kV
Applicable Standard	IEC 60383-1 and IS 731	
Insulator Test Voltage		
Highest System Voltage	kV(RMS)	12
Visible Discharge Test	kV(RMS)	9
Wet-Power frequency withstand	kV(RMS)	28
Minimum power frequency flashover voltage <ul style="list-style-type: none">DryWet	kV	78 45
Power frequency puncture withstand test	kV	145
Impulse voltage withstand test	kV peak	75
Dimensions		
Nominal diameter	mm	255
Nominal spacing	mm	146
Nominal creepage distance	mm	25mm/kV
Mechanical Load		
Approximate weight	kg	5.2
Cantilever strength (Minimum failing load)	kN	70
Color	-	Brown

Table 59: Minimum Characteristics applied to Polymer Disc Insulators

Characteristics	Unit	11 kV	33 kV
Applicable Standard		IEC 61109 and IS 731	
Type of insulators		Composite	
Material of the insulator		Silicon rubber	
Material of the core rod		ECR grade Boron free	
Material of the housing & weather sheds		Silicon Rubber	
Material of the end fittings		spheroidal graphite cast Iron (SGCI) with hot dip galvanised	
Sealing compound of the end fitting		Silicon based sealant	
Type of sheds		Aerodynamic with alternating sheds	

Diameter of FRP rod	mm	24	
Insulator Test Voltage			
Highest System Voltage	kV(RMS)	12	36
Visible Discharge Test	kV(RMS)	9	27
Wet-Power frequency withstand	kV(RMS)	28	70
Minimum power frequency flashover voltage <ul style="list-style-type: none">• Dry• Wet	kV	110 70	140 95
Power frequency puncture withstand test	kV	145	185
Impulse voltage withstand test	kV peak	75	170
Nominal creepage distance	mm	25mm/kV	25mm/kV
Mechanical Load			
Cantilever strength (Minimum failing load)	kN	70	70
Color	-	Grey	

Details are given on drawing no. BPC-DDCS-2023-20/4-7

4.10.4 Insulator Hardware Fittings

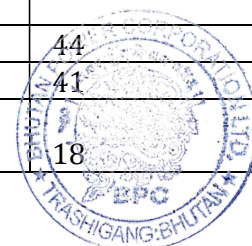
Fittings and accessories for polymer and porcelain disc insulator shall include a cross arm strap, a ball-eye, a socket-thimble, necessary end locking clips, nuts, and spring washers. The socket-thimbles shall be of aluminum alloy and suitable for preformed dead-end terminations and shall be supplied with a hot-dip galvanized hexagon cross-section cotter pin fitted with a humpback stainless steel split pin. For coupling between the clevis-thimble and the ball of insulator, a socket-eye shall be provided. Ferrous parts are to be galvanized and conform to IS: 2486. They shall be suitable for use with prescribed sizes of conductors. Details are given on drawing no. BPC-DDCS-2023-20/5-7,20/6-7.

4.10.5 Stay Insulators

In case of uneventful conditions (like leakage due to breaking of conductors etc.) the stay/guy insulator is provided for safety. Stay insulator shall be provided for all HT lines with bare or covered conductor however LT lines with LV ABC is not required. Stay/guy insulators are fixed in the stay wire at a height of not less than 3 m above the ground level. The insulator shall be suitable for 7/8 SWG guy wire preformed terminations. The insulators shall comply with IS: 5300.

Table 60: Minimum Characteristics of the Stay/guy Insulators

Characteristics	Unit	33 kV & 11 kV	415/240 ¹
Minimum failing load	kN	88	44
Creepage Distance	Mm	57	41
Dry one minute power frequency withstand voltage	kV(rms)	27	18



Wet one minute power frequency withstand voltage	kV(rms)	13	8
Length	Mm	140	90
Diameter	Mm	85	65
Cable hole dia	Mm	25	16

Note 1: For LV bare conductor. Details are given on drawing no. BPC-DDCS-2023-20/7-7

4.11 Earthing Equipments

4.11.1 Spike Earthing

Spike earthing is used for 11 kV & 33 kV pole earthing. Spike Earthing consist of 25x6 mm, 1.5 meter GI Flat, 2.5 meter long spike earthing electrode with necessary holes as indicated on the drawing no BPC-DDCS-2023-21/1-2.

4.11.2 Pipe Earthing

Pipe earthing is used for the earthing of distribution substations. Pipe earthing consists of heavy gauge GI pipe of 40 mm diameter, 4mm thick, 2500 mm long with perforation and 25x6 mm , 6.5 meter long GI Flat. One end of the GI pipe shall be threaded with 50 mm length to fix the plate (250x250 mm) and other end to be pointed to drive into the ground. Details are given on drawing no. BPC-DDCS-2023-21/2-2

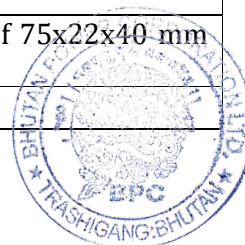
4.11.3 Stay Assembly

Stay assembly is installed at dead-end and angular locations to counter balance the load on the supports due to pulling of the conductors so that supports remain straight in vertical position without bending in any direction. They are also provided at mid-span support as a protection against the wind load. The stay set (Line Guy set) will consist of the following components:

Table 61: Specification of Stay Set

Description	33 kV & 11 kV
Anchor rod	2.5 metre long with 20 mm dia GI rod
Stay plate	300X300X6 mm with 22 mm hole at its centre
Turn buckle, eye bolt with nuts.	20 mm dia G.I rod, 460 mm long.
Bow with welded channel (V Hanger) only for telescopic structure.	16 mm dia G.I rod. The apex or top of the bow shall be bent at an angle of 10R. The other end shall be welded with proper and good quality welding to a G.S. Channel 200 mm long having a dimension of 100x50x6 mm. The Channel shall have 2 holes of 18 mm dia at its centre.
Thimble 2 Nos.	1.5 mm thick GI sheet into a size of 75x22x40 mm and shaped as per standard.
Preform 4 nos.	Preform suitable for stay wire.

Details are given on drawing no. BPC-DDCS-2023-22



4.11.4 Stay Wire

Utilities grade galvanised steel strand shall be used for guy wire as shown in table 62.

Table 62: Galvanised Steel Stay Wires

Designation	No Strands	Strand SWG	Strand Diameter (mm)	Overall dia	Appro. Wt. Per meter (kg)	Minimum breaking load (kN)
7/8	7	8	4.04	12	0.72	90

Care must be taken in procuring guy wire to ensure that the wire has the minimum breaking load specified in table 62. Galvanised steel wire is available in a range of steel grades and only utilities grade wire, manufactured using a high tensile steel, should be used.

4.11.5 GI Shielding Wire

Shielding wire shall be made up of good quality material and all nuts, bolts, spring washers and flat washers and connectors shall also be hot dipped galvanized. The technical specification of earth shield wire shall be as below:

Table 63: Specification of Shielding Wire

Sl#	Parameters	
1	Material	Galvanized stranded steel wire
2	Strands	7/2.0 mm (SWG 7/14)
3	Breaking Capacity	15.4 kN
4	Tensile Strength	700 N/sq.mm
5	Diameter of the wire	2 mm with +0.05 mm tolerance
6	Standard length of shield wire /drum	2.5 km
7	Approximate Weight	174.6 kg/km

4.11.6 Guard Wire

Guarding may be used for bare overhead conductor where power line crosses a street or road. Guard wires shall be of galvanized steel 8 SWG having breaking strength not less than 635.02 kg. Guard wires installed shall be earthed at all points. The details are discussed under section 5.4.

4.12 Overhead Line Conductors

The table below indicates detail of conductors standardized for use in medium voltage and distribution system for various types of lines.



4.12.1 Aluminium Conductor Steel Reinforced Conductor

ACSR conductor consists of seven or more aluminium and galvanized steel wires built up in concentric layers. The centre wire is of galvanized steel and the outer layer is of aluminium as per IS: 398 (Part II).

Table 64: Characteristics of Bare Overhead Line Conductors

Parameter	WOLF	DOG	RABBIT
Conductor type	ACSR		
Aluminium area (mm ²)	150	100	50
Equivalent copper area (mm ²)	96	64	32
Stranding and wire dia (mm)	30/2.59 Al. 7/2.59 Steel	6/4.72 Al. 7/1.57 Steel	6/3.35 Al. 1/3.35 Steel
Conductor diameter (mm)	18.1	14.2	10.1
Approximate mass (kg/km)	730	390	210
Minimum breaking load (kN)	69.2	32.7	18.4
DC resistance at 20°C (ohms/km)	0.1831	0.2745	0.5449
AC resistance at 75°C (ohms/km)	0.22	0.33	0.66
Approx inductive reactance (ohms/km)	0.257	0.276	0.397
Approximate voltage drop (mV/A/m) ¹	0.586	0.745	1.334
Full load current (A) ²	405	291	190

Note:

1. Phase to phase voltage drop on a balance three phase circuit.
2. Ambient temperature 40°C, conductor temperature of 75°C and wind speed of 1m/sec.

4.12.2 All Aluminium Alloy Conductor Covered

The detail specifies the covered conductor (CC) having conductor material AAAC, Alloy 1120 suitable for overhead lines for working voltages 6.35/11 kV and 19/33 kV, 50 Hz. AC system. The cover insulation shall be UV stabilized XLPE insulation. The covered conductors shall be marked on the external surface with the following:

- Manufacturer's name.
- Year of manufacture
- Length in metres marking in sequential numbers at 1 m intervals, with the lowest number at the inner end of the drum.
- Covered conductor type CC
- Conductor material AAAC, Alloy 1120

Table 65: The Minimum Technical Requirement of the AAAC Covered

	Units	Conductor size and type
--	-------	-------------------------

Applicable Standard	IEC 60502, IEC 60228			
Nominal cross-sectional area	mm ²	49.5	111	158
Calculated equivalent aluminium area	mm ²	47.2	106	150
Stranding and nominal wire diameter	No./mm	7/3.00 (Fluorine)	7/4.5 (Hydrogen)	19/3.25 (Krypton)
Conductor Material	Aluminium Alloy 1120			
Cover insulation material	UV stabilized XLPE			
Approximate overall conductor diameter	mm	9	13.5	16.3
Minimum thickness of XLPE cover	The thickness of the XLPE insulation shall be specified for each of the nominated working voltages.			
Overall diameter of the cable (approx.)	mm	12.4 - 14	16.9 - 18.5	19.7 - 21.3
Max. Conductor DC resistance at 20°C	Ohm/km	0.641	0.253	0.164
50Hz Inductive Reactance	Ohm/km	0.312	0.297	0.281
Continuous current rating	Amps	215	290	375
Weight of Conductor without insulation.	kg/km	135	304	433
Weight of conductor with insulation.	kg/km	340	500	710

NOTE:

The insulation characteristics to be taken care during detail design engineering based on test certificates submitted by manufacturer.

AAAC covered is mainly used where ROW is reduced and transient fault are common. They are cheaper than HV ABC. It is suitable for stringing across protected biological corridors and valleys where special geographical textures exist.

4.12.3 High Voltage Aerial Bundle Conductor

HV ABC consists of XLPE insulation. It has bearer wire (Messenger wire) which is either of aluminium alloy or steel wire (bare or insulated). The design of ABC shall comprise compacted, stranded, hard drawn aluminum phase conductors with dry cured cross linked polyethylene insulation. The main advantages of HV ABC over bare ACSR conductors are as follows:

- Offers relative resistance to short circuits caused by external forces (wind, fallen branches), unless they abrade the insulation.
- Can stand in close proximity to trees and branches will not generate sparks if it in contact
- Simpler installation, as cross arms and insulators are not required.
- Less cluttered appearance than bare conductors.
- It can be installed in a narrower right-of-way.



However, the disadvantages are, it is expensive and moreover, line spans are shorter and further increase the cost. The Insulation of the cable also degrades due to direct exposure to sun.

Table 66: Minimum Technical Requirement of the HV ABC

Parameters	Unit	11 kV	
Applicable Standards	IEC 60502-2, IEC 60228 or equivalent standard		
Rated Voltage	kV	6.35/11(12)	
Conductor			
Nom. Area of core Conductor	mm ²	50	95
Conductor Screen Material	Extruded cross-linked semi-conductive		
Min. Thickness of Conductor Screen	Mm	0.3	0.3
Insulation			
Insulation material	XLPE		
Min. Thickness of Insulation	Mm	3.4	3.4
Min. Thickness of insulation Screen	Mm	0.8	0.8
Metallic Screen			
Material	Plain Annealed Copper Wire		
Size for Conductor Screen	No./mm	26/0.85	26/0.85
Sheath			
Material	Black, High Density Polyethylene (HDPE)		
Min. Thickness of sheath	Mm	1.8	1.8
Support Catenary			
Support Catenary size	No./mm	19/2	19/2
Material	Aluminium-Clad Steel (bare)		
Max. D.C Resistance of cable at 20°C	Ohm/km	0.641	0.320
Max. A.C Resistance of cable at 90°C	Ohm/km	0.822	0.411
Inductive Reactance of cable at 50Hz	Ohm/km	0.144	0.134
Voltage drop (three phase)	mV/A.m	1.45	0.746
Continious current carrying capacity per phase at 90°C Conductor tempt & 30°C ambient Tempt.	Amps	184	280
Approximate mass of cable	kg/km	2850	4090
Phase cable diameter (Nominal)	Mm	25	29

4.12.4 Low Voltage Aerial Bundled Conductor

Overhead low voltage distribution circuits shall use 50 mm² or 95 mm² hard drawn aluminium conductor, XLPE insulated aerial bundled conductor (ABC) in all cases. Individual cores are identified by the number of ribs on the insulation material. Two core cable shall be used for single phase distribution and 4 core cable for three phase. Applicable standard are IEC 60502-1 and IEC 60228.

Typical design parameters for the ABC cable used are given in table below:



Table 67: Typical Characteristics of Aerial Bundled Conductor

Cable Size (mm ²)	50		95		120
Parameter	2 core	4 core	2-core	4-core	4-core
Applicable Standard	IEC 60502-1 or equivalent standard				
Rated Voltage (kV)	0.6/1(1.2)				
Nominal conductor diameter (mm)	8.05		11.40		12.90
Average insulation thickness (mm)	1.5		1.7		1.7
Nominal overall diameter (mm)	23.8	28.7	31.8	38.4	42.2
Approximate mass (kg/km)	350	700	680	1,350	1660
DC resistance at 20°C (ohms/km)	0.641		0.320		0.253
AC resistance at 50 Hz 80°C (ohms/km)	0.796		0.398		0.315
Inductive reactance at 50 Hz (ohms/km)	0.086	0.093	0.080	0.087	0.0844
Voltage drop at 50 Hz, 80°C (mV/A/m)	1.60	1.39	0.81	0.71	0.564
Continuous current rating (A)	150	140	230	215	280
Fault current rating (kA for 1 sec)	4.1		8.3		11.3
Minimum bending radius core (mm)	65		90		102
Minimum bending radius cable (mm)	130	160	270	320	352
Minimum breaking load (kN)	14.0	28.0	26.6	53.2	67.2
Recommended highest everyday tension (kN)	2.52	5.04	4.79	9.58	12.10
Recommended maximum working tension (kN)	3.92	7.84	7.45	14.90	18.82

4.12.5 Low Voltage Overhead Service Cable

Low voltage overhead service cable shall be 650/1100 V two core or four core stranded copper conductor, PVC insulated, with high conductivity hard drawn copper conductors. The cable shall have an extruded PVC sheath in accordance with IEC 60502-1. Key electrical characteristics of BPC's overhead service line cable are given in table 68 below.

Table 68: Current Ratings of Overhead Low Voltage Service Cables

Cable Size (mm ²)	Single Phase (2 core)		Three Phase (4 core)	
	Maximum Current (A) ¹	Volt Drop (P-N mV/A/m)	Maximum Current (A) ¹	Volt Drop (P-P mV/A/m)
4	42	11.222	35	9.71
6	52	7.503	46	6.497
10	73	4.446	62	3.86

16	97	2.806	82	2.430
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Note 1: Current ratings given for maximum conductor temperature of 75°C

Single core copper cable with a neutral screen is an acceptable alternative to the twin conductor cable currently used. For three phase supplies three core plus neutral screen cable may be used. Neutral screen cable is considered safer for overhead service drops because the neutral conductor completely surrounds the phase conductor.

4.13 Underground Distribution Cable

4.13.1 33 kV and 11 kV Cable

The standard 33 kV & 11 kV cable for underground distribution is cross-linked polyethylene insulated (XLPE), PVC sheathed, cable manufactured to IS 7098-2 or IEC 60502-2 of following sizes. Cables shall be steel wire or steel tape armoured for more than 1 core whereas for single core, armouring shall be aluminium wire or aluminium tape.

The current carrying capacity of buried cables depends on the installation conditions, such as the thermal resistance of the soil and the presence of other cables. Manufacturers provide cable ratings for cable installed under defined conditions, which may not reflect the actual installation conditions in a particular situation. In order to provide for these uncertainties, the maximum design current for any underground cable should generally be limited to 90% of the ratings.

The design of 33 kV and 11 kV underground cables is unlikely to be voltage constrained since these cables are generally installed in urban areas where runs are relatively short.

Table 69: Typical 33 kV Cable Characteristics

Cross sectional area of Al conductor (mm²) 3 core	70	150	185	300	400
Overall diameter of cable (mm)	76	86	90	93	100
Approximate cable weight (kg/m)	7.5	9.39	10.32	11.13	12.48
Minimum bending radius (mm)	1140	1290	1350	1395	1500
DC resistance at 20°C (ohm/km)	0.443	0.206	0.164	0.1	0.0778
AC resistance at 90°C (ohm/km)	0.568	0.265	0.211	0.129	0.102
Impedance at 50 Hz (ohm/km)	0.367	0.197	0.171	0.131	-

Phase to phase voltage drop (mV/A/m)	0.635	0.341	0.296	0.227	-
Current rating – Air (A)	190	300	340	455	530
Current rating – buried direct (A)	160	240	270	350	395
Current rating- Duct (A)	140	215	240	310	355
Conductor 1 sec short circuit current rating (kA)	6.6	14.2	17.5	28.3	37.7

Table 70: Typical 11 kV Cable Characteristics:

Cross sectional area of Al conductor (mm²) 3 core	70	150	185	300	400
Overall diameter of cable (mm)	52	62	66	78	84
Approximate cable weight (kg/m)	3.39	5.51	6.21	8.84	10.31
Minimum bending radius (mm)	780	930	990	1170	1260
DC resistance at 20°C (ohm/km)	0.443	0.206	0.164	0.100	0.0778
AC resistance at 90°C (ohm/km)	0.568	0.265	0.211	0.13	0.102
Impedance at 50 Hz (ohm/km)	0.578	0.282	0.231	0.157	-
Phase to phase voltage drop (mV/A/m)	1.001	0.488	0.400	0.272	-
Current rating – Air (A)	196	309	354	472	545
Current rating – buried direct (A)	171	259	293	380	432
Current rating- Duct (A)	150	231	262	343	393
Conductor 1 sec short circuit current rating (kA)	6.58	14.1	17.39	28.2	37.6

Table 71 : Typical 33 and 11 kV Cable Characteristics

Cross sectional area of Al conductor (mm²) 1 core	33kV			11kV		
	630	800	1000	630	800	1000
Overall diameter of cable (mm)	60	65	70	50	54	59
Approximate cable weight (kg/m)	4.3	5.06	6.68	3.35	4.1	4.78
Minimum bending radius (mm)	720	780	828	750	810	885

DC resistance at 20°C (ohm/km)	0.0469	0.0367	0.0291	0.0469	0.0367	0.0291
AC resistance at 90°C (ohm/km)	0.0630	0.051	0.043	0.063	0.051	0.043
Current rating – Air (A)	770	870	950	780	780	960
Current rating-Buried Direct (A)	495	540	570	510	510	590
Current rating- Duct (A)	420	460	490	435	435	500
Conductor 1 sec short circuit current rating (kA)	59.2	75.5	94.3	59.2	75.5	94.3

Table 69, table 70 and table 71 gives the short circuit current rating of different conductor sizes. However the limiting factor determining the short circuit current rating of a cable is generally the rating of the screen. Screen short circuit ratings of 10 kA for 1 second shall be specified for all cable sizes. Given its low conductor fault rating, 70mm² cable should not be used within 2 km of a zone or transmission substation.

4.13.1 400 V Cable

BPC's standard 400 V underground cable is aluminium conductor, PVC insulated, PVC sheathed, manufactured to IS 1554-1. Cables are four or two core with the neutral conductor having the same cross sectional area as the phase conductors. Cables shall be steel wire or steel tape armoured for more than 1 core whereas for single core, armouring shall be aluminium wire or aluminium tape.

Typical data on the standard cable sizes used by BPC is given in table 72 below. While the data does not specifically relate to cables manufactured to IS 1554, it relates to similar cables and is sufficiently accurate to use for design purposes.

Table 72: Data on Standard 400 V Underground Cable – Three Phase

Cable Size (mm ²)	No of Cores	Current Rating (A) (In Ground) ¹	AC Resistance (ohms/km)	Reactance (ohms/km)	P-P Voltage Drop (mV/A/m)
630 ²	1	390	0.0563	0.0800	0.1694
400	1	325	0.0934	0.0829	0.2163
400	4	335	0.0988	0.0732	0.2130
300	4	305	0.1250	0.0732	0.2509
150	4	210	0.2530	0.0745	0.4568
70	4	135	0.5420	0.0770	0.9482
35	4	92	1.0600	0.0826	1.8415

Note 1: These ratings are for BPC use. They incorporate a safety factor and may be used for design purposes.

Note 2: Cable with XLPE insulation

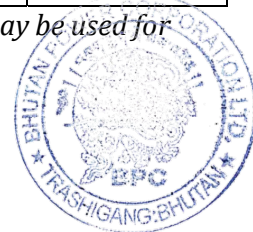


Table 73: Data on Standard 230 V Underground Distribution Cable – Single Phase

Cable Size (mm ²)	No of Cores	Current Rating (A) (In Ground) ¹	AC Resistance (ohms/km)	Reactance (ohms/km)	P-P Voltage Drop (mV/A/m)
16	2	60	2.3300	0.0861	4.6632
10	2	47	3.700	0.0906	7.4022
6	2	35	6.2411	0.0967	12.4836

4.14 Distribution Transformers

Distribution transformers may be either sealed or use tank breathers and shall comply with the specifications given in table below:

Table 74: Standard Specification for Distribution Transformers

Parameter	Requirement
Applicable standard	IS 2026, IEC 60076
Type	Oil filled ¹ / two winding
Winding material	Copper
Core Material	CRGO silicon steel/Amorphous Metal
Cooling	Oil natural air natural (ONAN)
Terminations <ul style="list-style-type: none"> Primary Secondary 	Outdoor Bushing or cable box ² Outdoor Bushing or Cable box
Rated no load voltage <ul style="list-style-type: none"> Primary Secondary 	33 kV or 11 kV 415/240 V
% Impedance 10 kVA-24 kVA (1phase/3phase) 25 kVA-630 kVA 631 kVA-1250 kVA	3% 4% 5%
Vector group	Dyn11
Tap changer <ul style="list-style-type: none"> Type Range Step value 	Off load +5% to -5% 2.5%
Insulation Class (IEC-76)	A
Permissible Temperature rise <ul style="list-style-type: none"> Maximum winding temperature Max. Top oil temperature 	55°C 50°C
Insulation levels <ul style="list-style-type: none"> Primary Secondary 	170 kVp-70 kV/75 kVp-28 kV 7500 Vp-3000 V
Min. Clearances between Bushing (Outdoor) <ul style="list-style-type: none"> HV phase to phase/phase to earth 	351/320 mm (33 kV), 280/140 mm (11 kV) 75/40 mm

<ul style="list-style-type: none"> • LV phase to Phase/phase to earth 	
Min. Clearances between Bushing (Indoor) <ul style="list-style-type: none"> • HV phase to phase/phase to earth • LV phase to Phase/phase to earth 	350/222 mm (33 kV), 130/80 mm (11 kV) 25/20 mm
H.T Bushings <ul style="list-style-type: none"> • 12 kV bushings • 36 kV bushings 	Conforms to I.S: 3347 Part III(Sec 1&2) Conforms to I.S: 3347 Part V(sec 1&2)

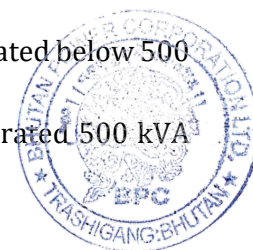
Note 1: Dry-type transformers conforming to IEC 60076-11 and IS 11171 shall be used if the transformer is to be installed indoors.

Note 2: Bushing for pole mount and cable for pad mount as per the specific requirement at site.

4.14.1 Standard Fittings

The following standard fittings shall be provided:

- Rating and terminal marking plates non-detachable of aluminum material
- Earthing terminals with lugs - 2 Nos.
- Lifting lugs for main tank & top cover
- Pulling lugs - 4 Nos
- HV bushings with arching horns
- LV bushings inside the cable box as per site requirement and neutral bushings (for high rating transformers).
- Metallic conservator tank (mandatory for 50 kVA and above for rated voltage 11 kV and below, and all ratings above 11 kV) with oil gauge
- Terminal connectors on the HV/LV bushings
- Thermometer pocket with cap.
- Air release device (bolted type) for all transformers fitted with conservator tank
- Radiators
- Prismatic oil level gauge
- Drain cum sampling valve
- Oil filling hole having M30 thread with plug and drain valve on the conservator
- Silica gel breather (25 kVA and above for rated voltage 11 kV and below and all ratings above 11 kV). Type of breather (Bolted type is preferred).
- Pressure relief device or explosion vent.
- Metallic off-load tap changer
- Base channel ISMC 125 x 65 mm with M16 bolts and nuts to fix on mounting platform (for pole mounted stations, spacing of the holes to be decided base on pole type (steel swaged / telescopic pole).
- MCCB at LT side inside a cable box for pad mounted transformers rated below 500 kVA.
- ACB at LT side inside a cable box for pad mounted transformers rated 500 kVA and above.



Transformers of capacity 125 kVA and below will be mounted on pole platform structures with four 16 mm dia bolts. The bolts spacing shall be 400 mm centre-centre for transformers up to and including 25 kVA and 500 mm centre- centre for transformers above 25 kVA capacity. The transformer tank base shall be provided with two steel channels to allow bolting to pole platforms. The 2 holes on the same channel should be spaced 227 mm centre-centre for transformers up to and including 25 kVA and spaced 242 mm centre- centre for transformers above 25 kVA capacity.

Pad mounted transformers below 500 kVA shall have skid type under base channels having towing holes for pulling & mounting holes for foundation of transformer. For heavy transformers of 500 kVA and above, the under base shall be equipped with rollers allowing the unit to be maneuvered into final position and then anchored. The Foundation drawings are provided as drawing no.BPC-DDCS-2023-38.

For 1250kVA & above rating transformer, the foundation drawings shall be designed by E&RD as required.

Standard distribution transformer capacities are given in table 75.

Table 75: Standard Distribution Transformer Capacities

Mounting type	33 kV system		11 kV system	
	3-phase (kVA)	1-phase (kVA)	3-phase (kVA)	1-phase (kVA)
Pole mounted Transformer (kVA)	125, 63, 25	25, 16	125, 63, 25, 16	25, 16, 10
Pad mounted Transformers (kVA)	1250, 1000, 750, 500, 315, 250	-	1250, 1000, 750, 500, 315, 250	-

4.14.2 Protection of Distribution Transformers

Type of protection provided for distribution transformer is given in the table shown below:

Table 76: Protection of Distribution Transformer

Sl #	Voltage ratio (Volts)	Capacity (kVA)	Protection	
			Primary side	Secondary side
1	11000/415-240, 33000/415-240	10, 16, 25, 63, 100, 125	Dropout fuse	Moulded case circuit breaker (MCCB)
2	11000/415-240, 33000/415-240	250, 315,	Dropout fuse	Moulded case circuit breaker (MCCB)
3	11000/415-240, 33000/415-240	500, 750, 1000, 1250, 1500	DO(500kVA) & CB(VCB OR SF ₆)	ACB
4	11000/415-240, 33000/415-240	>1500	CB(VCB OR SF ₆)	ACB



Wherever circuit breakers are provided for pad mounted distribution transformers i.e. for transformers 500 kVA and above, following protections are recommended:

- IDMT type over current and earth fault relay.
- Oil temperature indicator and winding temperature indicator with one electrical contact for alarm and trip shall be provided.
- Buchholz relay with alarm and trip contacts shall be provided.

For pole mounted transformers, the secondary side MCCB shall be located at the transformer Distribution Board whereas transformers rated 250 kVA and above, the secondary side protection MCCB /ACB shall be located at the LV cable box of the transformer itself.

4.15 Unitized Substation/Compact Substation (USS/CSS)

USS/CSS consists of distribution transformers which are assembled complete with high and low voltage switchgear in sheet metal “kiosks” or enclosures and are known as unit type substations. Such units are neat, compact and occupy less space and are especially designed for congested urban areas. The unit can be placed close to the load thus saving cost of cables. It should essentially include following items:

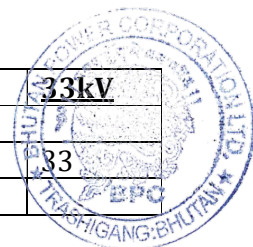
- The enclosure of the packaged substation having three compartments like: HT compartment, transformer compartment and LT compartment.
- The MV switchboard (Ring Main Unit) type.
- The distribution transformer
- The LV switchboard.
- Other operating accessories including necessary control & protection system, voltage & current measuring instruments, power pack with 2 hours minimum back-up for 24 V DC control supply, space heater with thermostat arrangement for enclosure cabinet heating and adequate illumination arrangement inside the cabinet. General arrangement of compact substation given on drawing no.BPC-DDCS-2023-23.
- The Foundation drawings are provided as drawing no.BPC-DDCS-2023-37A, B&C. Along with the Foundation Drawings of RMU(6 ways) as as drawing no.BPC-DDCS-2023-39

USS/CSS is available for following transformer capacities:

- 500 kVA
- 630 kVA
- 750 kVA
- 1000 kVA

Table 77: General Characteristic of the CSS

Description	units	11 kV	33kV
Applicable standards	IEC 62271-200		
Operating voltage	kV	11	33
MV Insulation Level			



Rated withstand voltage at power frequency(50 Hz/1 min)	kV rms	28/75	70/170
MV Network and Busbar			
Rated current	A	630	630
Rated short-time withstand current (Minimum)	kA rms/ 3s	20	16
LV Network			
Rated voltage	V	415	415

4.15.1 MV Switchgear/Ring Main Unit (RMU)

The RMU shall be compact, metal-enclosed indoor switchgear in accordance with IEC 298. It shall include within the same stainless steel /metallised epoxy enclosure, all the live parts and the switching equipment. The configuration of the ring main unit will depend on number of breaker feeder (transformer feeder) and network disconnecter (T-off). The switchgear and busbar enclosure shall be filled with SF6 at 0.2 bar to 0.8 bar relative pressure to ensure the insulation and breaking functions. The enclosure shall meet the "sealed pressure system" criterion in accordance with the IEC 298 standard. The switchboards shall have an IP2XC protection index. The tank shall be made of at least 2.5 mm unpainted stainless steel and be able to withstand an accidental internal overpressure of at least 3 bars (3000 hPa).

RMU is installed on medium voltage distribution network and is designed for use in the following applications:

- Compact secondary substations.
- Small industries.
- Hotels, shopping centers, office buildings, business centers etc.
- Airports and hospitals.

Depending on site situations, RMU can either be indoor or outdoor type. Following are the component of RMU:

- **Isolators with Earth switches (Network)**

The load break isolators with ES are provided at incoming and outgoing supply point and are fully insulated by SF6 gas. The operating mechanism shall be spring assisted mechanism with operating handle for ON /OFF. The earth switch shall be naturally interlocked to prevent the main and earth switch being switched 'ON' at the same time.

- **Vacuum Circuit Breaker (Transformer feeder)**

The 3 pole circuit breaker for the protection of distribution transformers shall be enclosed in the RMU. The rated breaking and making current at rated voltage shall be as follows:

- Rated breaking capacity shall be 20 kA for 3 second.
- Rated making current shall be 50 kA for 3 second

The circuit breaker unit shall be fitted with 3 nos protection CT's (tape wound) of relevant ratio and protection class having low burden and trip coil and auxiliary switch assembly allowing the use of a self powered non directional IDMT over current and earth fault relays shall be provided.



- **Busbars**

Three no's of continuous Busbars made up of EC grade tinned copper of rating current 630 A shall be provided. The Short time rating current shall be 20 kA for 3 seconds for 11 kV.

- **Cable Compartments**

RMU must be equipped with outer cone connection bushings. Cable compartments shall be air insulated suitable for dry type cable terminations. The connection points of each outgoing feeder must be horizontally situated in one level at a height of approximately 700 mm starting from the bottom of the unit. Provision for cable entry to RMU shall be indicated by the supplier/manufacturer. If used cable connections, the size shall be 3Cx150-400 sq.mm XLPE Al. armored with PVC sheath.

- **Remote Control of the RMU**

Remote operation of the RMUs must be possible using motors fitted to the operating mechanism for both line-switch and branch circuit-breaker functions. The RMU motors shall be rated 24 V/110 V, DC based on available DC supply, if no DC source, RMU shall include power pack unit.

It shall be possible to fit the motors either directly in manufacturing plant or on site when required. The fitting of the motors to the mechanism must not in any way impede or interfere with the manual operation of the switches. An auxiliary contact to prevent motorised operation of the mechanism while the operating handle is inserted into the operating point must also be provided. A DC supply (inverter and battery) with a back up time of 2 hours shall be provided with the RMU. The unit can be equipped with different types of communication media.

- **Fault Passage Indicator (FPI)**

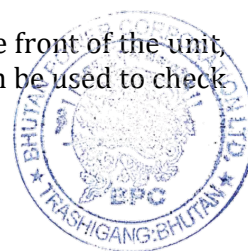
These shall facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The unit should be self-contained requiring no auxiliary power supply. The FPI shall be integral part of RMU. Electronic fault passage indicator for each isolator switches may be provided as optional feature. It is desirable to have fault passage indicator fully field programmable having sufficient settings for E/F and Phase - Phase. Also should have a SCADA output contact usually provided on feeder without breaker.

- **Voltage Indicator Lamps and Phase Comparators**

The RMU shall be equipped with a voltage indication. There should be a facility to check the synchronization of phases with the use of external device. It shall be possible for each of the function of the RMU to be equipped with a permanent voltage indication as per IEC 601958 to indicate whether or not there is voltage on the cables.

The capacitive dividers will supply low voltage power to sockets at the front of the unit, an external lamp must be used to indicate live cables. Three outlets can be used to check the synchronization of phases with the use of an external device.

- **Earthing**



The RMU, switch gear, load break isolators, distribution transformer, M.S. Channels / M.S. angles etc., shall be equipped with an earth bus securely fixed along the base of the RMU and necessary connectors and clamps for this purpose shall be included in the scope of supply. The size of earth busbar of tinned copper flat shall be as per IEC/IS standards and shall be fixed inside the RMU. For each CSS, a total of 4 earth pipes of 40 mm diameter MS rod of 3 meters in pits shall be erected. The earth pipes are to be connected in a grid formation. Necessary terminal clamps and connectors shall be included in the scope of supply.

- **Front Plate**

The front plate shall include a clear mimic diagram which indicates different functions. The position indicators shall give a true reflection of the position of the main contacts. They shall be clearly visible to the operator. The lever operating direction shall be clearly indicated in the mimic diagram. The manufacturer's plate shall include the switchboard's main electrical characteristics.

- **Danger Board**

The danger board as per relevant IS shall be riveted on the front plate of the RMU.

4.15.2 Transformer

Specification of pad mounted oil immersed transformers for 500 kVA, 750 kVA and 1000 kVA is given in section 4. The transformer HT bushing shall be of indoor type with bushing caps for cable connection. Direct connection shall be provided with the help of insulated flexible XLPE Al cables or PVC sleeved Al/Cu busbars between RMU bushings to transformer bushings. PVC sleeved Aluminium busbars to be direct connected between transformer LV bushing and ACB terminal pad in LV compartment.

4.15.3 LV Switchboard

The LV Switch board should be smooth finished, leveled and free from wobbling. Doors, removable covers, if any and plate shall be gasket all around with neoprene gaskets, and this is essential to prevent ingress of dust and vermin. All live parts shall be provided with at least phase to phase and phase to earth clearance in air of 25 mm and 20 mm respectively. The construction system shall provide a complete set of elements for installing fixed or withdrawal switching and protective devices, measuring devices and control/monitoring devices in the switchboard. The LV Switchboard shall be provided with incoming ACB of following ratings:

- 1600-2000 A – 1000 kVA transformer
- 1250 A – 750 kVA transformer
- 1000 A – 630 kVA transformer
- 800A – 500 kVA transformer



Table 78. Specification of Air Circuit Breaker (ACB)

Sl. No.	Description	Unit	Particulars
1	Rated Frequency	Hz	50
2	Phase	Ph	3
3	Rated Current	Amps	2000,1600,1250,1000 & 800 as per the requirement
4	Rated operational voltage	V	415
5	Release	-	Microprocessor based
6	Breaking capacity	kA	50
7	Type	-	Manual/Fixed

- **Moulded Case Circuit Breaker (MCCB)**

The outgoing feeders shall be provided with the MCCB of appropriate rating. MCCBs shall be heavy duty type, mounted on bases, having a rupturing capacity of 50 kA at 415V A.C. 50 Hz. Outgoing MCCBs are to be supplied and installed as part of the completed LV switchboard with the following parameters: Refer IEC 60947-2

Table 79. Specification of MCCB

Sl. No.	Description	Unit	Particulars
1	Rated Frequency	Hz	50
2	Phase	Ph	3
3	Rated Current	Amps	630, 400, 300 as per the requirement
4	Rated operational voltage	V	415
5	Breaking capacity	kA	50
6	Release	-	Static
7	Type	-	Manual/Fixed

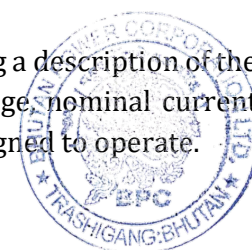
- **Interior Lighting of LV Switchboard**

Each panel should be provided with a lighting fixture (11W) rated for 240V, 1 phase, 50 Hz supply for the interior illumination of the panel and 3 pin power socket to be used during maintenance. The respective panel door switch shall control switching of the fitting. All lamps shall be with pin type holder.

- **Labels**

All LV Switchgear shall be provided with labels or name plates, giving a description of the equipment, together with information regarding the nominal voltage, nominal current and the like under which the item of plant in question has been designed to operate.

- **CSS Metering**



Metering shall be provided either on HT side or LT side based on the requirement. The meters shall be suitable for both 3 phase 3 wire and 3 phase 4 wire metering configuration as desired by the user. All meters should be able to take measurement at 5 amps/1 amps of the secondary CT ratings.

4.15.4 Outdoor Enclosure

The enclosure should be made of hot dip galvanized steel sheet. The metal base should be made of 4mm hot dip galvanized steel and ensures rigidity for easy transport and installation. The structure of the substation should be capable of supporting the gross weight of all equipment. The roof of the substation compartment should be designed to support loads up to 250 kg/m² and be slanted to 20°. Intermediate ceiling roof should be provided. A minimum clearance should be maintained between the top of any component installed in the substation and the roof of the substation. Protection degree of the enclosure for MV and LV compartments should be not less than IP 54 in accordance with IEC 529. Protection degree for Transformer compartment should be not less than IP 23D. Ventilation apertures should be sufficient for natural ventilation (Class K10). MV and LV compartments should be accessible on the sides of the substation through double doors equipped with key lock, and rubber seals. The doors can be padlocked and/or lock protected. The outgoing of the distribution transformer should be connected directly to the incomer of the LV distribution through busbars. All metallic compartments shall be earthed to a common earthing point. Internal lighting to be activated by associated switch for each compartment. The packaged substations should have successfully passed internal arcing withstand tests 20 kA 1s.

4.16 Low Voltage Distribution Boards

Low voltage distribution pillar has been categorized to following terms and dimensions:

- **Transformer LV Distribution Board**

The distribution board for pole mounted transformers shall now be categorized as transformer LV Distribution Board. Transformer LV Distribution Board shall be of two dimensions, one for single phase and other for three phase as shown in the drawing no. BPC-DDCS-2023-24A and 24B. The incoming MCCB shall be housed inside the transformer LV Distribution Board.

- **Mini Feeder Pillar**

Previously known mini pillar shall be named as mini feeder pillar which comes with only busbars. Standard dimension of mini feeder pillar is given on drawing no. BPC-DDCS-2023-25.



- **Transformer Distribution Pillar**

Distribution board for pad mounted transformer shall be named as transformer distribution pillar. The fuse rating of the outgoing feeders shall be kept lower than incoming feeder. Two sizes of distribution pillar are given in the drawing no. BPC-DDCS-2023-26 and 27. The incoming MCCB and ACB to be located at transformer LT chamber due to space constraint for cable termination at transformer distribution pillar.

- **Line Distribution Pillar**

Line Distribution Pillar shall be of two sizes as given in the drawings no. BPC-DDCS-2023-26 and 27. The fuse rating of the outgoing feeders shall be same as the incomer. The rating of the fuse shall remain same in 4 ways and 6 ways to form a ring system.

4.17 Surge Arrestors

The surge arresters shall be of the metal oxide, gapless, single pole type, suitable for outdoor use on a three-phase 50 Hz system and shall have the following parameters:

Table 80: Specification of Surge Arrestors

Parameter	33 kV	11 kV
Applicable standard	IS 3070, IEC 60099-4	
Rated Voltage (rms)	30 kV	9 kV
Nominal discharge current (kA)	10 kA	10 kA
MCOV	24.4 kV	7.65 kV
Maximum Residual Voltages for:		
Steep Current impulse (1/20 micro sec.)	85 kV	26.5 kV
Lightning Impulse protection level (8/20 micro sec.)	71.8 kV	21.7 kV
Switching impulse protection level (30/60 micro sec.)	60 kV	18 kV
Type of Housing Insulator	Polymer with alternating sheds	
Moisture sealing system	Housing directly molded onto the arrester. Housing pressed on arrester with caps at the end not acceptable.	
Colour	Grey/Brown	

Note: Ground and line lead of the arrester is important. The lead voltage can contribute as much as the arrester protective level for long length. Therefore, arrester lead length shall be as short and straight as possible.

4.17.1 Arrester Fittings

Surge arresters will be connected between phase and earth to protect distribution transformers and switchgear. It shall be complete with the following:



- Arrester terminal shall be nut and bolt (M12), suitable for connecting lugs with 14 mm dia hole or clamp type to accommodate standard conductor sizes used by BPC.
- Earth connection lead or earthing clamp terminals.
- The surge arresters shall be provided with mounting brackets complete with bolts, nuts and washers, suitable for mounting either vertically or horizontally on cross-arm channel (ISMC 75x40) bearing 18 mm dia holes.
- Disconnecter device for disconnecting it from the system in the event of arrester failure to prevent a persistent fault in the system and it shall give a visible indication when the arrester has failed. The arrester disconnecter shall be tested as per IEC 60099-4.
- Over pressure relief device shall be provided for relieving internal pressure in an arrester and preventing explosive shattering of the housing following prolonged passage of flow current or internal flashover of the arrester.

4.17.2 Consideration at High Altitude

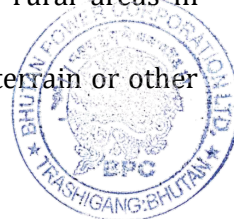
- If low altitude designed arrester is used at high altitude, possibility exists that the internal pressure of the arrester will be sufficiently high to cause a leak in the seal arrester allowing moisture to enter it causing failure. Therefore due attention must be given to moisture sealing system employed by the manufacturer.
- A second potential problem exists with the new metal oxide arresters in which the overall length of the housing is decreased substantially. Attention must be given to assure that an adequate margin exists between the arrester protective characteristics and the external flashover of the housing at high altitude.

4.18 Auto-reclosers

A recloser is a protection device for electrical distribution networks. It has a circuit breaker that trips if an over-current is detected by an electronically-controlled reclosing function. It can automatically restore power to the affected line by clearing the fault itself. The benefits of deploying reclosers in the networks are; the reclosers prevent transient short circuits from triggering prolonged power outages. This results in better supply continuity to customers. The second benefit is that reclosers restore power automatically, without requiring an engineering site visit.

4.18.1 Situations where Auto-Reclosers may be used are:

- Used to clear transient faults.
- Used to prevent urban consumers being affected by faults in rural areas in situation where feeder serves both urban and rural customers.
- Used to segregate a line which has high fault frequency due to terrain or other factors.
- Can be used to segregate faults between two areas or ESDs



- Can be used for temporary substations
- Used in substation instead of building full substation
- Used for feeder automation, generator control and smart grid.
- Used for loop automation in tie lines.

This equipment should generally be used if the line length of spur feeder or length from mid-point is more than 20 km. This condition, however, should not apply if it is being used in substation, loop automation, feeder automation, generator control or in smart grid.

Table 81: Specification of Auto-Recloser

Sl#	Particular	33 kV	11 kV
1	Rated Voltage	33kV	11kV
2	Applicable standard	IS 7567, IEC 62271 – 111	
3	Type	Outdoor, Pole mounted	
4	Frequency	50 Hz	
5	Rated Power Frequency withstand Voltage (kV)	70	28
6	Rated Lightning impulse withstand voltage(kV)	170	75
7	Rated continuous current(Amps)	300 Amps and above	300 Amps and above
8	Fault make capacity (RMS)-KA	12.5	12.5
9	Fault make capacity (Peak)-KA	31.5	31.5
	Fault breaking capacity	12.5	12.5
10	Protection Features	Overcurrent	Overcurrent
		Earth fault	Earth fault
		Sensitive Earth Fault	Sensitive Earth Fault
		Negative phase sequence	Negative phase sequence
		Over/Under frequency	Over/Under frequency
		Over/Under Voltage	Over/Under Voltage
		Live load blocking	Live load blocking
		Cold load pick up	Cold load pick up
		Inrush restraints	Inrush restraints
11	Metering/Measurement features	Voltage	Voltage
		Current	Current
		Frequency	Frequency
		Kilowatt (kw)	Kilowatt (kw)
		Apparent Power (kVA)	Apparent Power (kVA)
		Reactive power (kVAR)	Reactive power (kVAR)
		Power factor	Power Factor
		Energy (kwhr)	Energy (kwhr)
		Outage Measurement	Outage Measurement

Sl#	Particular	33 kV	11 kV
14	Communication features	Local: Serial/TCP/IP and USB port	Local: Serial/TCP/IP and USB port
		Remote: Serial/TCP/IP	Remote: Serial/TCP/IP
13	Interrupting medium	Vaccum	Vaccum
14	Insulation	SF6/Solid Di-electric material	Solid Di-electric material
17	Mechanical operating life	Minimum of 10,000 operations	

Note: Higher external BIL ratings are required due to high altitude which can be taken care by providing higher rating bushing insulators on it.

4.19 Fault Passage Indicators

Fault passage indicators detects the short circuit and earth fault currents in overhead line networks and indicates it with LED flash lights and/or red flag. It must be installed at well-defined strategic locations along the overhead line such as: start of a spur line or bifurcation point and sectionalizers. It can be mounted directly on the MV conductors.

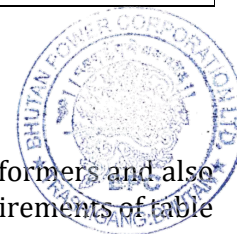
The electro-magnetic field generated by the line current induces a voltage in the indicator coil or antenna. This voltage is fed to a di/dt analogue sensor in order to discriminate between a normal load current and a real fault current. A normal variation of the load current will not cause to activate LED lights or red flags. The automatic reset can be performed by means of the built-in voltage sensor. A metal sheet acts as a capacitor between the phase conductor and the electronics, therefore sensing the electric field generated by the Medium Voltage.

Table 82. General Technical Requirement Fault Passage Indicator

SL#	Technical Parameters	Requirements
1	Fault Type	Earth fault and short circuit
2	Applicable Voltage grade	6.6-33 kV
3	Applicable wire cross-section	50-400 mm ²
4	Standard reset time	Adjustable
5	Static power consumption	1uA or less
6	Applicable ambient temperature	-40°C~50°C
7	Relative humidity	20% to 100%
8	Maximum elevation	4000 m
9	Indication mode	Red flag and LED flash light

4.20 MV Drop-Out Fuses

Medium voltage drop out fuses are needed to protect distribution transformers and also to protect lightly loaded spur lines. Fuse bases shall conform to the requirements of table



shown below. The medium voltage fuse barrel carrying fuse links shall be of the disconnecting type suitable for opening, closing and removal when energised using an insulated operating stick.

Table 83: Standard Specification for Medium Voltage Drop Out Fuse Bases

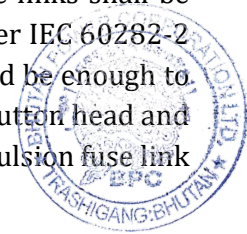
Parameter	33 kV	11 kV
Applicable standard	IEC 60282-2, IS 9385 I-III	
Type	Expulsion drop out type for outdoor use	
Rated current of the fuse base (A)	100	100
Rated load breaking capacity (A)	6	20
Insulation level:		
Dry Impulse withstand (1.2 kV/50 μ s) voltage (positive & negative polarity) (peak)		
• Across the isolating distance of the fuse base kV	195	85
• To earth and between poles kV	170	75
Wet 1 min. Power frequency withstand voltage (rms.)		
• Across the isolating distance of the fuse base kV.	80	32
• To earth and between poles kV	70	28
Rated short time breaking capacity (kA)	8	10
Minimum Creepage Distance	900	300
Mounting Arrangement	Vertical Mounting on two Channels	

Note: When fuses are required to be used above 1000 m, the rated insulation levels to be specified should be determined by appropriate correction factors.

Each cutout unit shall be supplied complete with connection terminals suitable for conductors ranging in size from 16 mm² to 120 mm². Details are given on drawing no. BPC-DDCS-2023-28 for 11 kV and 33 kV systems.

4.20.1 Fuse link

The fuse link shall be suitable for A.C system with a maximum system voltage of 12 kV and 36 kV and frequency of 50 Hz. The fuse link shall be suitable for use in distribution fuse cut out, drop out type. The size of fuse link required will depend on the transformer size and should be in accordance with table 85. The wire expulsion fuse links shall be removable button head, single tail, Type T designed and constructed as per IEC 60282-2 of current ratings as given in table. The strain wire tensile strength should be enough to withstand pull forces and any mechanical shock in excess of 4.5 kg min. Button head and contact washer should be Tin/Silver plated. The overall length of the expulsion fuse link



shall be 610mm to suit wide range of the fuse holders (fuse carriers) used on 11 kV and 33 kV system. The fuse link shall be of following ratings:

Table 84: Fuse Link Rating

Rated Voltage	Rated current (Amps)	Rated breaking capacity
12 kV	1, 2, 3, 6, 8, 10, 12, 15, 20, 25, 30, 40, 50, 65, 80, 100	10 kA
36 kV	1, 2, 3, 6, 8, 10, 12, 15, 20, 25, 30, 40, 50, 65, 80, 100	8 kA

Note: Details of fuse link shown in drawing no. BPC-DDCS-2023-28

4.20.2 D.O. Barrels (Carrier Tube)

The carrier tube shall be made of Epoxy Resin Fibre Glass (ERFG). The tube shall have an electrical grade tube with good mechanical and high heat resistance properties. Inside liner of the fuse tube shall be constructed of a synthetic arc quenching material. The external surfaces shall be uniformly finished with polyurethane and varnish or epoxy resin. The tube shall have a temperature index of at least 155°C. A removable button head type fuse link shall be able to fix to the arc shortening tube. The installation and removal of the fuse carrier shall be facilitated by inserting the operating rod into a lifting eye at the hinge end (lower) of the fuse carrier when it is in the dropped out position. An operating lever eye shall be provided at the top of the carrier to facilitate a downward pull by the operating rod to release the latch incorporated in the stationary upper contact. All castings such as upper and lower moving and fixed contacts, clamp type terminals, toggle mechanism shall be of phosphor bronze, silicon bronze, aluminum bronze or Silver-plated brass. The fuse barrel shall be as per the dimension indicated in the drawings.

4.21 Medium Voltage Load Break Switches

Pole mounted load break switches are used for sectionalising 33 kV and 11 kV feeders but are no longer used in distribution substations. They shall be air break, three pole, single throw, quick acting and fitted with load break heads.

4.21.1 Load Break Switch (LBS)/ Air Break Switch

Load Break Switch / Air Break Switch is a manually operated switch used for breaking and making the circuit on load without damage to the switching equipment. This switch is supplied fitted with load break arc interrupters to allow the switch to be used to interrupt load currents in accordance with IEC 60265-1. Air break switches are generally used outdoor for circuits of medium capacity such as long lines supplying a village/industrial /commercial loads from main line/feeder for isolation and switching. LBS should be installed at start of a spur line for isolation and safety. Typical Drawing of LBS/ABS is given on drawing no. BPC-DDCS-2023-29A & B.

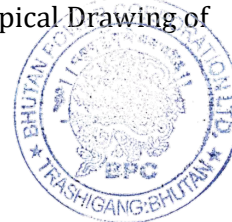


Table 85: Standard Specification for Medium Voltage Load Break Switches

Parameter	33 kV	11 kV
Applicable standard	IEC 62271-102 & IEC 62271-103	
Rated normal current (A)	630	630
Rated 3 sec withstand current (kA)	16	20
Rated peak withstand current (kA)	40	40
Rated power frequency withstand voltage		
1. Across open contacts (kV)	80	32
2. To Earth and Between poles (kV)	70	28
Rated impulse withstand voltage		
1. Across open contacts (kV)	195	85
2. To Earth and Between poles (kV)	170	75

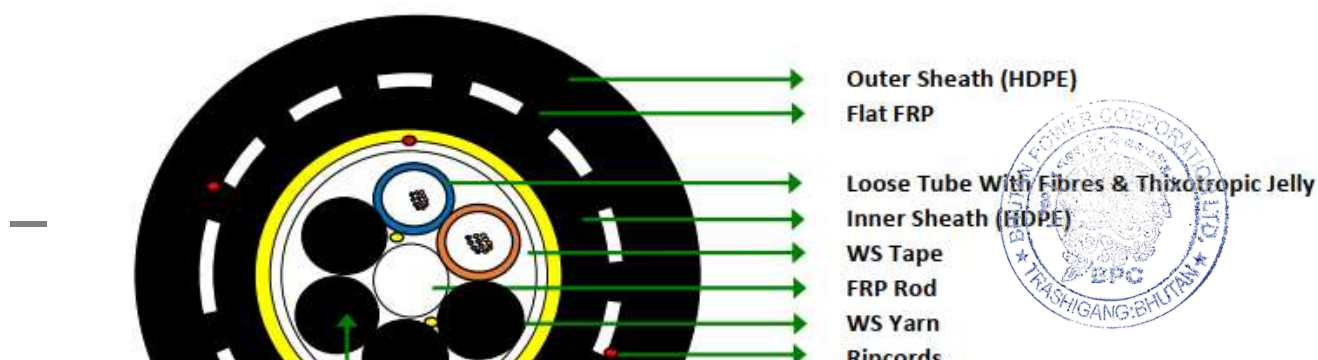
4.22 Optical Fiber cable – ADSS

All-dielectric self-supporting (ADSS) cable is a type of optical fiber cable that is strong enough to support itself between structures without using conductive metal elements. ADSS cable is designed to be lightweight and small in diameter to reduce the load on tower structures.

ADSS accessories can be tension type which is used at deadends where cable terminates or changes directions and suspension type only holding the weight of a span with tension transmitted through the next span of cable.

Fiber cables are generally supported on the lower cross-arms of the tower, which provides good clearance to the ground. The ADSS shall be in accordance with IEC60793, IEC60794 & relevant standard.

Cross Section diagram of ADSS cable



Technical particulars of 24F SM G652 D FLAT FRP ANTIRODENT ADSS OFC

1. Fiber properties			
Sl.No	Characteristics	Unit	Value
1	Attenuation @ 1310 nm @1550 nm	dB/km	≤ 0.34 ≤ 0.20
2	Chromatic dispersion between 1285 – 1330 nm 1550 nm	ps/(nm ² km)	≤ 3.5 ≤ 18
3	Zero dispersion wavelength	Nm	1300 to 1324
4	Zero dispersion slope	ps/(nm ² km)	≤ 0.092
5	Cut off wavelength	nm	≤ 1320
6	Mode field diameter at 1310 nm	μm	9.1 ± 0.5
7	Core-clad concentricity error	μm	≤ 0.6
8	Cladding non circularity	μm	$\leq 1.0\%$
9	Cladding diameter	μm	125 ± 1.0
10	Coating diameter	μm	245 ± 10
11	Polarization mode dispersion	ps/ $\sqrt{\text{km}}$	≤ 0.20
2. Mechanical & Environmental properties			
A	Tensile Strength	KN	13.0
B	Max. installation tensile	N	3500 N
C	Crush resistance	Newton/10cm	2000 N/ 10 cm
D	Min. Bending radius (static)	mm	12.5 x D mm
E	Min. Bending radius (dynamic)	mm	25 x D mm
F	Max. operating /installation temperature	°C	20 °C to +65 °C
G	SPAN LENGTH	M	200 M
H	SAG (ISTALLATION)		2%
I	Wind speed	KM/H	100 KM/H
3. Physical & dimensions properties			
I	Number of fibers		24F
II	Loose Tube / Dummy		2/4
III	Type of fiber		SM G652D
IV	loose tube Material / Diameter (INNER)		PP (Polypropylene)
V	Strength Member		FRP ROD & FLAT FRP
VI	Color of fiber		BLUE, ORANGE, GREEN, BROWN, GREY, WHITE, RED, BLACK, YELLOW, VIOLET, PINK & AQUA
VII	Color of loose tube/ dummy		BLUE, ORANGE, GREEN, BROWN, FILLER-1, FILLER-2
VIII	Inner sheath materials		HDPE - BLACK
IX	Inner sheath thickness	mm	0.80 mm NOMINAL
X	Outer sheath materials		HDPE - BLACK

XI	Outer sheath thickness	mm	1.70 mm NOMINAL
XII	Outer Cable Diameter	mm	13.90 mm + 5 %
XIII	Cable weight	KG	160 kg/km + 15 Kg/Km
XIV	Standard length	KM	2 km + 5%



5. CONSTRUCTION STANDARD

5.1 Overhead Lines

5.1.1 Choice of Route

The route selected for an overhead line should be the one that will give the lowest cost over the life of the line. Route selection therefore involves consideration of a number of factors, including the cost of landowner compensation, the cost of transporting materials to the site, construction cost and the cost of ongoing maintenance requirements including vegetation control. As a general rule, line routes should be as short as practicable and should run as close to a road as possible since this facilitates access for both construction and maintenance. Consideration should also be given to the location of possible future line extensions, either to supply potential new loads or to service towns and villages that are currently electrified. Following parameters should be kept in mind:

- The shortest route practicable.
- As close as possible to the road for easy maintenance and approach during construction.
- Route in direction of possible future load.
- Angle points should be less.

Where possible, distribution line routes should avoid steep hills or valleys, swamps, lakes, thick forests, rivers or other locations where access is difficult or long spans are required. When building along a road, pole positions should not cause a traffic hazard or be in locations where there is a higher probability of vehicle impact.

The following should be avoided wherever possible:

- Areas likely to be used for future urban development;
- Routes incorporating sharp changes in line direction;
- Routes close to aerodromes;
- Religious monuments;
- Special trees of religious significance;
- School playgrounds;
- Cemeteries; and
- Buildings containing explosives.

Construction of lines over private land involves negotiation of a right of way and payment of compensation, and is to be avoided if a cost effective alternative route along public roads is available.



5.1.2 Approval of Line Routes

Prior to the erection of lines along public roads, the authority responsible for the road should be contacted and approval obtained for the location of all poles, road crossings, tree cutting or trimming, and guying locations. Where overhead distribution lines are to be constructed in urban areas, it will also be necessary to contact the local Town Planning Authority for approval. Where appropriate, approval should also be obtained from authorities such as the National Environment Commission, Department of Forestry, etc.

Once the line route is finalized, a detailed line survey should be undertaken and the pole locations finalized and marked. Poles should be located well clear of water and other areas of potential land subsidence. Poles for lines that cross agricultural fields should, wherever possible, be located at bunds. Procedure for Obtaining Environmental Clearance for the new project from National Environment Commission Secretariat (NECS) is given below:

1. Duly filled IEE form/EA form/EIA report.
2. Records of public consultation signed by members of the concerned local authority present during the public consultation.
3. Written consent from individual or juristic person if activity has direct impact on a property authenticated by the concerned local authority.
4. Forwarding letter from the concerned Competent Authority with the following
5. Revenue Money Receipt (RMR) of the application fees.

The forestry clearance shall also be required for RoW clearing.

5.1.3 Tree Clearances

The width of line route to be cleared of trees will depend upon the voltage and the importance of the line concerned. While no rigid limits are provided, the following clearances should be adhered to, as far as possible.

Table 86: Tree Clearance Distances

Voltage	Comment
Low voltage ABC	Left to the discretion of the supervisor. Aerial bundled low voltage conductor is insulated so contact with vegetation should not cause a fault. However the route should be cleared so the risk of tress falling on the line is minimised.
11 kV lines (Bare Conductor)	The route should be cleared of all growth within 4.5 m of the centre line and, in addition, of trees that could fall and contact the line.
33 kV lines (Bare conductor)	The route should be cleared of all growth within 6 m of the centre line and in addition, of trees that could fall and contact the line.
AAAC Covered Conductor	The route should be cleared of all growth within 4.5 m of the centre line and, in addition, of trees that could fall and contact the line.

5.2 Overhead Line Construction

The construction of overhead lines may be divided as follows:

5.2.1 Pit Making and Digging Procedure

After surveying, the pole location should be marked with peg. The pits should not be too large than necessary, as otherwise, after erection of the pole and filling there remains a possibility of tilting of pole. For Steel Swaged poles, the depth of the foundation shall be 1700 mm for 10 m pole, while the size of the foundation pit will be 600x800mm with longer axis in the direction of the line.

For Telescopic pole, the depth of the foundation shall be 1870 mm for 11.2 metre pole and 2000 mm for 12 m pole, while the size of the foundation pit shall be 800x1000 mm.

5.2.2 Erection of Supports

Before erection of the galvanised Steel swaged poles, pole cap and suitable base plate shall be fixed at the pole base to increase the surface contact between the pole and the soil. Once the pole is erected inside the pit, wooden deadmen may be utilized to facilitate lifting of the pole. Once lifted into the pit, the pole should be kept in a vertical position with the help of ropes, using them as a temporary anchor. It should be ensured that, at the time of erection, four men are at the ropes and the supervisor should be at a distance for guiding correct position so that in the event of breaking of rope, if pole falls, it will not result into an accident.

As the poles are being erected, say from an anchor point to the next angle point, the alignment of the poles is to be visually checked and set right. The verticality of the poles shall be checked with a spirit level in both transverse and longitudinal directions. In case of LV lines, the holes for fixing hook brackets should also to be checked to ensure they are facing the proper direction.

Once the verticality and alignment are satisfactory, the pit shall be backfilled and compacted to a distance of 450mm below ground level. A 450 x 450 mm (HT) & 350x350mm (LT) concrete foundation shall then be constructed around the pole and extending to 300 mm above the ground level as shown in the relevant drawings. The concrete shall be a mixture of cement, granite chips of 20/30 mm mesh and sand in the ratio of 1:2:4. The top of the foundation shall be tapered to allow water to run away from the pole.

The foundation should be backfilled with excavated soil and the backfill should be progressively compacted by sprinkling water at every 500mm layer as the foundation is filled. Do not simply refill the foundation and compact at the surface.

After the poles have been set and the excavated pit backfilled and compacted, the temporary anchors may be removed.



5.2.3 Erection of Double Pole Structures for Angle Locations

On medium voltage lines, where the angle of deviation is more than 10 degrees, a double pole structure shall generally be erected. The pits are to be excavated along the bisection of the angle of deviation. If the angle of deviation is more than 60 degree, a four pole structure is to be used as shown in drawing no. BPC-DDCS-2023-31.

After erection of the poles the pits will need to be temporarily backfilled so the poles can be climbed and the horizontal bracing fitted. The structure should then be set for verticality and alignment and the supports held in position with the help of temporary rope guys.

The temporary backfilling should be removed and permanent foundations constructed by backfilling, compacting and, if necessary, concreting each pit as described in section 5.2.2. Concrete foundations are not required if the poles are hot dipped galvanised.

Guys along the bisection of the angle of deviation, as required by the conductor size and angle of deviation, are to be provided. These shall be constructed in accordance with section 5.2.5.

5.2.4 Special Foundation

a) Unstable Soil

Special care has to be taken where foundation in unstable soil is encountered.

In such locations, mass concrete foundations, extending the full length (below the ground) of the pole, are to be adopted to avoid collapse of foundation in the unstable soil. The concrete is to be a mixture of cement, granite chips of 20/30 mesh and sand in the ration of 1:2:4.

b) River Crossing

For line crossing rivers, RCC foundation shall be used for the pole structures.

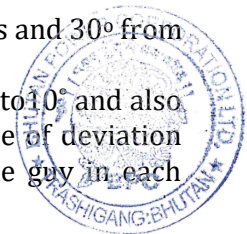
5.2.5 Anchoring and Providing Guys for Supports

One or more guys shall be provided for all supports where there is an unbalanced force on the support that may result in tilting/ uprooting or breaking of the support. Normally, these guys are provided at the following locations:

- Angles;
- Dead end locations;
- Tee-off points; and
- Steep gradient locations to avoid uplift on the poles.

Guy wires shall be angled at 45° from the vertical for 33 kV and 11 kV lines and 30° from the vertical for low voltage lines.

Single guys shall be provided for single poles with line deviations from 5° to 10° and also for double poles with line deviations not exceeding 30°. Where the angle of deviation exceeds 30°, two guys along the resultant angle of line deviation or one guy in each



direction of the line shall be provided. When two or more stays are fixed to the same support, each stay should be attached separately to the pole.

The installation of guy will involve the following works:

- Excavation of pit and fixing guy rod;
- Backfilling and compacting the guy foundation;
- Fastening guy wire to the support; and
- Tightening guy wire and fastening to the anchor.

After completion of installation work the foundation shall be allowed to consolidate for at least 7 days before installation of the guy wire. When installing the guy wire, the turnbuckle shall be mounted at the pole end of the stay and guy wire so fixed that the turnbuckle is half way in the working position; thus giving the maximum movement for tightening or loosening. No guy insulator shall be located less than 3 m from the ground. While binding the stay, pole should not be tilted. Thimble is necessary for stay binding. Where sufficient space is not available, the arrangement such as bow guy and stud pole support as shown in drawing no. BPC-DDCS-2023-30 may be adopted.

5.2.6 Fixing of Cross Arms and Insulators

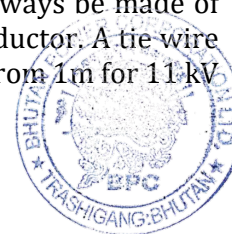
The practice of fixing the cross arm and top hamper before the pole erection is acceptable. If the cross arm is mounted after the support is erected, all the materials or tools required should be lifted or lowered by means of the hand line.

In such case, lineman should climb the pole with necessary tools. The cross arm is then tied to a hand line and pulled up by the ground man through a pulley till the cross arm reaches the line man. The ground man should station himself on one side, so that if any material drops from the top of the pole, it may not strike him. All the materials should be lifted or lowered through the hand line, and should not be dropped. Horizontal cross arms and pole top brackets shall be fitted as shown in the relevant drawings.

Line conductors are electrically insulated from each other as well as from pole by insulators. There are two types of porcelain insulators.

- The pin type insulators are generally used for straight stretch of line. The insulator and its pin should be mechanically strong enough to withstand the resultant force due to combined effect of wind pressure and weight of the conductor in the span.
- The strain insulators are used at terminal locations or dead end locations where the angle of deviation of the line is more than 10° .

In general the tie wire should be the same kind of wire as the line wire i.e. aluminium tie wire should be used with aluminium line conductor. The tie should always be made of soft annealed wire so that it may not be brittle and injure the line conductor. A tie wire should never be used for second time. The length of the wire will vary from 1m for 11-kV insulators to 3 m for 33 kV insulators.



5.2.7 Erection of ACSR Conductor

During running out, the conductor drum should be securely supported on drum jacks with an axle, so that the conductor is pulled from the top of the drum. The drum jacks should be on a firm foundation and the axle of the drum jack should be levelled horizontally. Care must be taken to ensure that the conductors are not damaged by contact with the ground or pole hardware during running out and that kinking, twisting or abrading the conductor is avoided. The conductor should not be trampled on, run over by vehicles or dragged over the ground.

Extreme care must be taken to avoid contact with the conductors of any other live line in the vicinity when running out or stringing conductors, and if necessary neighbouring lines should be de-energised during the stringing operation.

Stays shall be installed and kept in position before conductors are strung to avoid over straining of poles. Stringing pulleys shall be used while stringing conductors.

5.2.8 Mid-Span Jointing of Conductors

Mid-span jointing of conductors shall use compression joints correctly sized for the conductor and made with a proprietary compression tool using correctly sized dies. Before jointing, the conductor ends should be properly cleaned. In case of copper, clean by sand paper and for aluminium conductor, first apply jointing compound and then brush so as to remove the aluminium oxide. Mid span joints shall be avoided in the long spans such as river crossing, valley, etc.

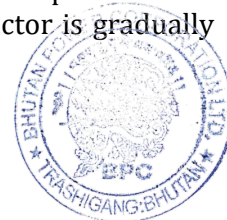
5.2.9 Jumpering

The jumper should always be connected through P.G. clamps. Care should be taken that mid span joint will not be less than 40 ft. from pole. Every joint should be done carefully. Where conductor strands are cut, repair sleeve is used. Conductor joint strength should be 95 % that of conductor, and resistance should be that of main conductor.

5.2.10 Sagging and Tensioning of Conductors

After completion of conductor stringing and making any mid-span joints, conductor tensioning operations can commence. The conductors are first attached to the insulator string assembly at the non-tensioning end of the section, using preformed dead-ends. Further, before tensioning commences, temporary guys should be provided as necessary for the anchoring supports at each end of the line section to be tensioned to avoid over-stressing the strain poles due to unbalanced loads.

The centre conductor should be tensioned first followed by the outer two conductors. At the tensioning end, the conductor being tensioned is pulled manually up to a certain point and then a come-along clamp is fixed to it. The grip to the come-along clamp is attached to a double sheave pulley block or a pull-tight machine and the conductor is gradually tensioned.



The conductor should then be sagged in accordance with the sag-temperature chart for the particular conductor and span. The correct sag should be measured in the middle span of the section.

The stretch of the conductor has to be taken out before sagging in order to avoid the gradual increase in sag, due to the setting down of the individual wires. There are two ways of accomplishing this:

- **Prestressing**

Using the prestressing method, the conductor is pulled unto a tension considerably above the correct figure, but never exceeding 50% of breaking load for a period of about twenty minutes. As this method requires more time and involves the use of stronger tackle to secure the higher tension, it is not commonly used.

- **Overtensioning**

The over tensioning method consists of pulling up the conductor to a tension of 5%-8% above the theoretical tension for the prevailing temperature and fixing the conductor at that tension with correspondingly reduced sag. Over time, the conductor will settle down to the correct sag and tension.

Conductors can be sagged correctly only when the tension is the same in each span throughout the entire length of the section. Use of snatch blocks during sagging reduces the friction and chances of inequality of tension in various spans.

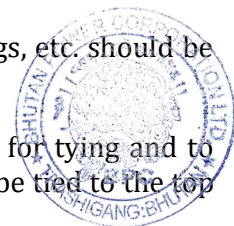
Measurement of conductor sag can be accomplished by several different methods but most commonly used method is 'sighting'. Targets are placed on the supports below the cross arms. The targets may be light strips of wood, which are clamped to the pole at each end of the sagging span at a distance below the conductor when the conductor is placed in snatch blocks that is equal to the required sag. A lineman sights the sag from the next pole and the tension of the conductor is reduced or increased, until the lowest part of the conductor in the span coincides with the lineman's line of sight.

When sagging is completed, the preformed dead end should be fixed to the tension end. The dead-end and socket thimble can be fitted to the conductor without releasing the tension. A mark is made on the conductor at a distance from the cross arms equal to the length of the complete strain insulator to indicate where the dead-end should be installed.

After the dead-end has been installed and the insulator string attached to the top hamper or cross-arm, the conductor is pulled in sufficiently using the come-along clamp, to allow the insulator assembly to be fitted to the socket thimble. After the conductor is attached, the conductor tension may be released gradually. If the tension is released with a jerk, an abnormal stress may be transferred to conductor and support, which may result in the failure of the cross arms, stay or pole.

After the stringing is completed, all poles, cross-arms, insulators, fittings, etc. should be checked to ensure that there have been no deformities, etc.

The conductor is then placed on the pin insulator on each pole ready for tying and to remove the snatch blocks. On straight line poles the conductor should be tied to the top



groove of the insulator and on angle poles the conductor should be tied to the side groove. The conductor is then fastened to the insulator using aluminium helities or binding wire conforming to IS 12048.

In fastening the conductor to pin insulators, the following points should be observed:

- The correct size of binding wire, which can be readily handled, and with adequate strength should be used.
- The length of tie wire should be sufficiently long for making the complete tie including and end allowance for gripping each end.
- A good tie should provide a secure binding between the line conductor and insulator, and should reinforce the conductor on either side of the insulator.
- The use of cutting pliers for binding the tie wire should be avoided.
- A helitie or binding wire that has been used previously should not be reused.
- Before tying the conductor to the insulator, it shall be ensured that only the portion of helities wrapped with chloroprene pad (where applicable) touches the insulator.

At section poles correctly sized parallel groove (PG) clamps must be used to connect the two conductor tails.

5.2.11 Conductor Sag and Tension

The following sag-span tables are provided for the guidance of field staff when stringing conductors.

Table 87: Sag-Span Chart – 33 kV, WOLF

Conductor : WOLF
Voltage ; 33 kV
Design Tension : 3.42 kN at 15°C, no wind (approx 5% MBL)

Temp	10°C	15°C	25°C	30°C	75°C
Span (m)	Sag (m)				
40	0.37	0.42	0.51	0.55	0.70
50	0.60	0.65	0.75	0.80	0.97
60	0.88	0.94	1.04	1.09	1.28
80	1.61	1.67	1.78	1.84	2.04
100	2.55	2.62	2.73	2.79	3.27
150	5.82	6.00	6.00	6.07	6.60

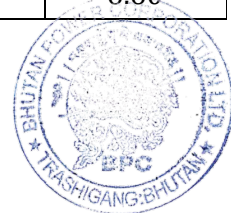


Table 88: Sag-Span Chart – 33 kV, DOG

Conductor : DOG
Voltage ; 33 kV
Design Tension : 1.95 kN at 15°C, no wind (approx 5% MBL)

Temp	10°C	15°C	25°C	30°C	75°C
Span (m)	Sag (m)				
40	0.34	0.40	0.50	0.55	0.88
50	0.56	0.62	0.73	0.79	1.17
60	0.83	0.89	1.01	1.07	1.49
80	1.52	1.59	1.72	1.78	2.26
100	2.38	2.45	2.59	2.65	3.19
150	5.44	5.52	5.66	5.73	6.33

Table 89: Sag-Span Chart – 33 kV, RABBIT

Conductor : RABBIT
Voltage ; 33 kV
Design Tension : 1.04 kN kg at 15°C, no wind (approx 5% of MBL)

Temp	10°C	15°C	25°C	30°C	50°C
Span (m)	Sag (m)				
25	0.125	0.157	0.231	0.266	0.389
30	0.187	0.227	0.310	0.350	0.488
35	0.262	0.308	0.400	0.443	0.595
40	0.352	0.403	0.501	0.547	0.712
60	0.845	0.907	1.023	1.078	1.280

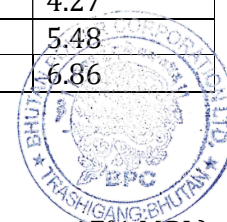
Table 90: Sag-Span Chart – 33 kV, AAAC Covered (111.3sq.mm)

Conductor : AAAC Covered (111.3sq.mm)
Voltage : 33 kV
Design Tension : 1.22 kN at 15°C, no wind (approx 5% MBL)

Temp	10°C	15°C	25°C	30°C	75°C
Span (m)	Sag (m)				
40	1.27	1.29	1.35	1.37	1.58
50	1.99	2.02	2.07	2.10	2.32
60	2.88	2.91	2.96	2.99	3.21
70	3.93	3.96	4.01	4.04	4.27
80	5.15	5.17	5.23	5.25	5.48
90	6.52	6.55	6.60	6.63	6.86

Table 91: Sag-Span Chart – 11 kV, WOLF

Conductor : WOLF
Voltage ; 11 kV
Design Tension : 12.11 kN at 15°C, no wind (approx 17% MBL)



Temp	10°C	15°C	25°C	30°C	75°C
Span (m)	Sag (m)				
40	0.11	0.12	0.15	0.17	0.54
50	0.17	0.19	0.23	0.26	0.71
60	0.24	0.27	0.33	0.37	0.89
80	0.43	0.47	0.57	0.63	1.28
100	0.68	0.74	0.87	0.95	1.71
150	1.56	1.66	1.88	1.99	2.99
200	2.82	2.95	3.23	3.37	4.56
250	4.46	4.62	4.93	5.09	6.43
300	6.47	6.65	6.99	7.16	8.63

Table 92: Sag-Span Chart – 11 kV, DOG

Conductor : DOG
Voltage ; 11 kV
Design Tension : 5.71 kN at 15°C, no wind (approx 17% MBL)

Temp	10°C	15°C	25°C	30°C	75°C
Span (m)	Sag (m)				
40	0.12	0.14	0.18	0.22	0.65
50	0.19	0.21	0.28	0.33	0.84
60	0.27	0.31	0.40	0.45	1.03
80	0.49	0.54	0.68	0.75	1.46
100	0.76	0.84	1.01	1.11	1.93
150	1.76	1.88	2.14	2.26	3.33
200	3.20	3.35	3.65	3.80	5.05
250	5.06	5.23	5.57	5.74	7.13
300	7.35	7.54	7.90	8.07	9.57

Table 93: Sag-Span Chart – 11 kV, RABBIT

Conductor : RABBIT
Voltage : 33 kV
Design Tension : 3.02 kN at 15°C, no wind (approx 17% of MBL)

Temp	10°C	15°C	25°C	30°C	50°C
Span (m)	Sag (m)				
25	0.047	0.054	0.076	0.093	0.220
30	0.068	0.078	0.108	0.131	0.280
35	0.093	0.106	0.146	0.174	0.344
40	0.122	0.139	0.188	0.222	0.412
60	0.278	0.313	0.404	0.460	0.720

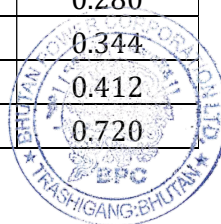


Table 94: Sag-Span Chart – 11 kV, AAAC covered (111.3sq.mm)

Conductor : AAAC covered (111.3sq.mm)
Voltage : 11 kV
Design Tension : 4.13 kN at 15°C, no wind (approx 17% of MBL)

Temp	10°C	15°C	25°C	30°C	50°C
Span (m)	Sag (m)				
40	0.29	0.38	0.52	0.58	0.98
50	0.50	0.59	0.75	0.81	1.27
60	0.77	0.86	1.02	1.09	1.60
70	1.07	1.16	1.33	1.40	1.96
80	1.43	1.52	1.69	1.77	2.36
90	1.84	1.93	2.10	2.18	2.80
100	2.29	2.38	2.55	2.63	3.28
150	5.26	5.35	5.53	5.61	6.34

Table 95: Sag-Span Chart – 11 kV, AAAC covered (48.98sq.mm)

Conductor : AAAC covered (49.98sq.mm)
Voltage : 11 kV
Design Tension : 2.01 kN at 15°C, no wind (approx 17% of MBL)

Temp	10°C	15°C	25°C	30°C	50°C
Span (m)	Sag (m)				
40	0.31	0.40	0.53	0.59	0.98
50	0.53	0.62	0.77	0.83	1.28
60	0.80	0.89	1.04	1.11	1.62
70	1.12	1.21	1.37	1.44	1.99
80	1.50	1.58	1.74	1.82	2.40
90	1.92	2.00	2.17	2.24	2.85
100	2.39	2.47	2.64	2.72	3.35
150	5.48	5.56	5.73	5.82	6.52

Table 96: Sag-Span Chart – 11 kV, HV ABC (95 sq.mm)

Conductor : HV ABC (95sq.mm)
Voltage : 11 kV
Design Tension : 3.72 kN at 15°C, no wind (approx 5% of MBL)

Temp	10°C	15°C	25°C	30°C	50°C
Span (m)	Sag (m)				
20	0.53	0.54	0.55	0.56	0.54
30	1.21	1.21	1.23	1.24	1.21
40	2.15	2.16	2.17	2.18	2.16
50	3.33	3.37	3.46	3.50	3.37
60	4.84	4.85	4.87	4.88	4.85

70	6.60	6.60	6.62	6.63	6.60
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Table 97: Sag-Span Chart – 11 kV, HV ABC (50 sq.mm)

Conductor : HV ABC (50 sq.mm)
Voltage : 11 kV
Design Tension : 2.01 kN at 15°C, no wind (approx 17% of MBL)

Temp	10°C	15°C	25°C	30°C	50°C
Span (m)	Sag (m)				
40	0.31	0.40	0.53	0.59	0.74
50	0.53	0.62	0.77	0.83	1.00
60	0.80	0.89	1.04	1.11	1.30
70	1.12	1.21	1.37	1.44	1.65
80	1.50	1.58	1.74	1.82	2.03
90	1.92	2.00	2.17	2.24	2.46
100	2.39	2.47	2.64	2.72	2.94
150	5.48	5.56	5.73	5.82	6.06

5.2.12 Supports at Different Elevation

Where the supports at each end of a span are at different elevations the following formula can be used for sagging the conductor.

$$d_1 = d(1-h/4d)^2$$

where: d_1 = vertical distance between the conductor at the lower support and the lowest mid-span point.

d = sag for a level span equal to the slope distance between the poles.
The slope distance is the distance that would be measured by a tape stretched between the two poles. Once the distance between the poles is known the value of d can be taken from Table 87 to 97.

h = difference in height between the conductor at each end of the span.

The above formula can be used to determine the value of d_1 . A sighting board can then be attached to the lower support pole and the conductor sagged be sighting horizontally through it. One way to do this would be to attach a second sighting board to the next pole. Check that the two sighting boards are level using a taut line and spirit level. The sag can then be sighted using the two sighting boards.

5.2.13 Good Conductor Stringing Work Practices

DO:



- Use proper equipment for handling aluminium conductors at all times.
- Use skids, or similar method for lowering reels or coils from transport to ground.
- Examine the reel before unreeling for presence of nails or any other object, which might damage the conductor.
- Rotate the reel or coil while unwinding the conductor.
- Unwind the conductor in the direction of the arrow on the side of the drum
- Grip all strands when pulling out the conductor.
- Control the unreeling speed with a suitable braking arrangement.
- Use wooden guards of suitable type to protect the conductor when pulling it over barbed wire fences, sharp rock edges or similar obstructions.
- Use long straight, parallel jaw grips with suitable liners when pulling the conductor in order to avoid nicking or kicking of the conductors.
- Use free-running sheaves or blocks with adequate grooves for drawing/paying conductors.
- Measure temperatures accurately with an accurate thermometer.
- Use proper sag charts.
- Mark conductors with crayons or adhesive tape or such other material which will not damage the strand.
- Make all splicing with the proper tools.

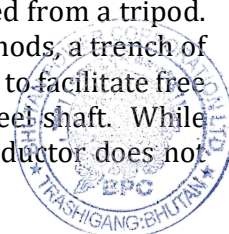
DO NOT

- Do not handle conductors without proper tools at any stage.
- Do not pull conductors without first ensuring that there are no obstructions on the ground.
- Do not pull out a greater quantity of conductor than is required.
- Do not make jumper connections on dirty or weathered conductor. Instead, clean the conductor with sandpaper. Alternatively apply a chromite or graphite conducting oxide-inhibiting grease to the point of connection and then clean the conductor with a wire brush.
- Do not handle aluminium conductor in a rough fashion but handle it with care it deserves.

At road crossings, a flagman should be in attendance to that traffic is not unduly interrupted. The running of conductor across roads should only be carried out in with the approval of the Authority responsible for the road.

Conductor drums should be transported to the tension point without injuring the conductor. If, it is necessary to roll the drum on the ground for a small distance, it should be slowly rolled in the direction of the arrow marked on the drum.

When running out conductor the drum should be so supported that it can be rotated freely. For this purpose, the drum should either be mounted on the cable drum supports or jacks or hung by means of chain pulley of suitable capacity, suspended from a tripod. If it is not possible to raise the conductor drum by any of the above methods, a trench of suitable depth slightly bigger than the conductor drum may be dug, so as to facilitate free rotation of the drum when it is suspended above the trench using a steel shaft. While running out the conductor, care should be taken to ensure that the conductor does not



rub against any metallic fitting of the pole or on the uneven or rocky ground. Wooden trusses may be used for this purpose to support the conductor when running out.

Should the length the conductor be less than the length of the section, the conductors should be run out from both ends and joined where they meet with a mid-span full tension joint.

On no account, should any part of the conductor shall be left overnight at a height of less than 5 metres above the ground. The work should be so arranged that before the end of the day, the conductor is raised to a minimum height of 5 metres above the ground by rough sagging.

5.2.14 HV ABC Accessories

The following accessories are required for the installation of the HV aerial bundled cables:

- Pole bracket assembly
- Suspension assembly
- Strain clamp/dead end assembly.
- GI support hook
- Bundled restraint assembly

Each assembly shall be complete with all necessary devices suitable for attachment to round steel poles by stainless steel strap. All metal fitting shall be of good quality galvanized mild steel or cast aluminum alloy. Each of the suspension/angle/dead end assemblies shall be supplied with a 1.75m of stainless steel strap with two buckles. Bundled end protection shall be provided for protecting cable dead ends and shall comprise a set of heat shrinkable polymeric terminal caps for fitting on each conductor, together with protective black PVC sleeve of 500mm length. The following connectors are required for the connection of HV aerial bundled conductors:

- (a) Insulated tension jointing sleeve
- (b) XLPE cable termination push on type

The connections shall be insulated and suitable for use on live lines. The teeth of the contact plates shall penetrate the bundled conductor insulation to establish contact with ABC cable without the need to strip the bundled conductor insulation. The connector shall be suitable for copper or aluminum tee-off conductor. Insulated tension jointing sleeves shall be provided for the bundled conductors. These shall be of the compression type, but compression shall not damage or displace the sleeve insulation. The sleeve connectors shall be designed to have the full rated breaking strength of the aluminium or aluminium alloy cable on which they are fitted.



5.2.15 Low Voltage Aerial Bundled Cable

A sag-span chart for ABC conductor, assuming typical installation conditions is given in table below.

Table 98: Sag-Span Chart for Low Voltage ABC

Conductor Size	50mm ²		95mm ²	
Design Tension at 15oC (kN)	2.52	5.04	4.79	9.58
Span (m)	Sag (m)			
30	0.15			
40	0.26			
50	0.41			
60	0.59			
70	0.80			
80	1.04			
90	1.32			
100	1.63			
110	1.97			
120	2.35			
130	2.75			

BPC uses 7.5 m poles to support ABC conductors, and the maximum allowable span length on level ground is shown in table 90 below. The table assumes the cable is located 150 mm from the top of the pole, depth of burial is 1/6 of pole length and that minimum ground clearances are as shown in table 9.

Table 99: Maximum Spans for Aerial Bundled Cable

Pole Length (m)	Maximum Span (m)	
	Across Street	Elsewhere
7.5	50	80 (4 core) 100(2 core)

In installing aerial bundled cable the cable must be pulled from the top of the drum and should not be dragged along the ground. A suitable 'drum brake' mechanism should be used to prevent conductor overrun. Stringing pulleys compatible with bundled conductor shall be installed on every pole. During running out, the cable should be pulled out by hand or by using a nylon pulling grip designed for bundled cables. Insulated conductor grips designed to prevent damage to the insulation of the conductor shall be used for tensioning. Every care must be taken to avoid damage to the conductor insulation.

Dead-end (termination) fittings shall be fitted to the conductor after tensioning at each termination point. Intermediate fittings shall then be fitted at major angles and then at

smaller angles. After all fittings are in place the sagging should be checked at two places and corrected if necessary. Insulation straps (cable ties) shall be used to tie the conductor at each supporting point.

5.3 Special Crossings

In case the lines cross-over the other lines or buildings, safe minimum clearance are to be maintained as mentioned in table 9. The other crossings could also include for:

- Telephone lines
- Lines of other voltages
- Roads, streets and rivers.

Double pole or 3 pole or 4 pole structure would be required to be specially designed, depending upon the span and conductor size for the river crossing. 12 m steel swaged pole shall be used in such situation.

5.4 Guarding

Guarding is an arrangement provided for the lines by which live conductor, when accidentally broken is prevented to come in contact with other electric lines, telephone lines, roads and persons or animals and carriages moving along the road, by providing a sort of cradle below the main electric line. The guarding is always earthed. In absence of guarding, conductor will fall on ground and as no protection is operated, conductor will remain charged. This will cause accidents. Hence the guarding is very essential.

Cradle guarding is adopted for lines with bare conductor at road crossing based on the risk imposed to pedestrian and vehicle plying below. Guarding shall be of 3 wire system. 1 wire on lower side and two on the upper side of the angle as shown in BPC-DDCS-2023-32. Requirement of guarding shall be as follows:

- Guarding is to be used for road crossing of power line with bare conductor only.
- G.I. wire of 8 W.S.G is used for guarding.
- The first lacing should be at a distance of 750 mm from the pole. Other lacing is tied at a distance of 3 meter from each other.
- The vertical distance between conductor and guarding in mid span should be 1220 mm.
- The clearance between line and guarding cross arm for 11 kV and 33 kV line should be 650 mm and 840 mm respectively.

5.5 Pole Earthing

All 11 kV and 33 kV steel poles should be separately earthed. The earth pin is a 2.5 m galvanised steel rod, which must be driven into undisturbed ground clear of the pit.



excavation. It is not acceptable to insert the earth rod in the pit excavation as the backfill used often does not provide a good earth connection.

The earth pin is connected to the pole using 5x5 mm² (Copper) or (5x12) mm² (Aluminium), 1.5 meter long covered wire. The wire is connected from the pole base to the spike rod using cable lug with nuts and bolts. Details of spike earthing are shown in drawing no. BPC-DDCS-2023-21.

The earth resistance of the pole and earth pin connected together should be as low as possible and ideally should not exceed 10 ohms. Additional earth pins, spaced at least 1 metre apart, should be used in difficult locations, to reduce the resistance. Stake earthing is not required for LV poles since the lines are of covered conductor.

The earthing stake for pole earths is also used for earthing LV distribution pillars.

5.6 Final Completion and Commissioning of MV Lines

Before a line is energised for the first time pre-commissioning installation work must be completed on each pole. This comprises:

- The attachment of anti-climbing device at a height of 3.5m to 4m from ground level to medium voltage pole to avoid unauthorized pole climbing. Fixing of danger notices to single/ double pole structure where required by BPC. The danger notices should be fixed about 2 meter above ground level and, where appropriate, should face the road or any track or other pedestrian walkway.
- Before commissioning a line into service, the line shall be visually checked over its full length to ensure that all structures are correctly installed, all pole earths are installed and connected, all conductors are correctly bound and terminated on all structures and all tools and other equipment have been removed.

The line shall be energised with all distribution substations isolated and unloaded on the low voltage side. Where the line is directly connected to a zone substation supply bus, rather than to an upstream line, the protective relay settings should be reduced. Once the line has been successfully energised, the correct protection relay settings should be applied and the distribution substations connected to the load one at a time.

5.7 Installation of Distribution Transformer

As discussed in previous section, transformer capacity of 125 kVA and below shall be pole mounted.

5.7.1 Pole Mounted Transformers

For installing pole-mounted transformers, as far as possible, subsidiary poles and street lighting poles should not be used as transformer poles. Special care should be taken to maintain proper climbing space and to avoid crowding of wire and equipments. Transformers should be installed only on poles strong enough to carry their weight.



Transformer poles should be straight and, where necessary, guyed to prevent leaning or raking of the pole after the transformer is hung. Double cross-arms should be provided for each transformer installation. The climbing space (2400mm Pole Center-Center) should be carefully maintained so that it should not be necessary for a lineman to come close to the transformer tank in climbing up or down a pole. An anti-climbing device should be provided.

5.7.2 Site Selection for Pole mounted Transformers

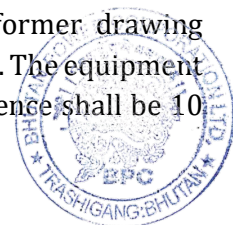
The location of pole mounted distribution transformer substations should ideally be:

- As close as possible to the centre of the load, in order to reduce the voltage drop in the low voltage circuits;
- In a location that is clear of obstructions and is that provides satisfactory access for the incoming medium voltage overhead distribution line;
- Readily accessible for transport of the distribution transformer to site;
- Above a road rather than below it where this is practical; and
- In a location likely to provide a low resistance to earth.

5.7.3 Pad Mounted Distribution Transformers

Since the transformers operate without moving parts, generally a simple foundation is satisfactory; provided it is firm, horizontal and dry as designed in drawing no. BPC-DDCS-2023-38. The transformer should not rock or bed down unevenly so as to tilt, as this may strain the connections. The base should be horizontal to keep the oil level correct. For outdoor transformers where rollers are not fitted, leveled concrete plinth with bearing plates of sufficient size and strength can be adopted. The plinth shall be above the maximum flood level of the site and of the correct size to accommodate the transformer in such a way so that no person may step on the plinth. Where rollers are fitted, suitable rails or tracks should be provided and when the transformer is in the final position, the wheels should be locked by locks or other means to prevent accidental movement of the transformer.

The foundation should be constructed of Plain concrete cement or reinforced, air entrained concrete having enough strength to hold the individual transformer load. The dimension of the plinth shall be designed based on approved transformer drawing however the height of the plinth shall be 1000 mm above the ground level. The equipment installed shall be enclosed by a chain link fence. The size of chain link fence shall be 10 mx10 m as shown in drawing no. BPC-DDCS-2023-33.



5.8 Substation Earthing

Particular care should be given to the construction of the earthing system as proper earthing of distribution transformer substations is necessary to ensure safe operation of the supply system. The earth pits should be located as shown in drawing no. BPC-DDCS-2023-34 and the earth connections to the substation structure are shown in drawing BPC-DDCS-2023-35.

BPC's standard earthing conductor for transformer substations is 25x6mm galvanised iron strap.

Three electrodes are used forming an equilateral triangle with minimum distance of 6500 mm, so that adequate earth buffer is available. Each Electrode shall be a GI pipe of 4mm thick, 40mm outer dia and 2500mm long and buried vertically so as to leave about 4 inch pipe length above ground level to fix a 250x250mm G.I plate. The three earth electrodes should be connected together by an equipotential earthing ring embedded at least 100 mm below ground level. These are connected as follows:

- One earth electrode is connected to each lightning arrestor and the transformer tank. It is important that the earthing conductor is kept as short as possible.
- The second earth electrode is connected to the transformer LV neutral bushing, the transformer tank and the crossarms supporting the drop-out fuses.
- The third earth electrode is also connected to the transformer tank and LV neutral and also to the earth in the low voltage distribution cabinet.

There shall be minimum joints preferably no joints enroute to earth electrodes. Where joints are unavoidable, they shall be brazed, riveted or welded and bolted (and painted with red lead and aluminum paints one after the other and finely coated with bitumen). Modern earthing compounds are recommended instead of salt and charcoal to reduce the earth resistance of the substation in extreme situations.

5.9 Transportation and Handling of Transformers.

Distribution transformers should be stored in such a way that 'first in and first out' becomes a normal procedure. Care must be taken to place the transformers in store in such a fashion that no damage occurs to tank, bushings, etc. due to movement of personnel and materials.

Transformers should be loaded and unloaded with care. Prior to loading a transformer for dispatch to site, the transformer condition (bushings, fittings, tank, oil level, etc.) should be checked. If any damage is noticed, the in-charge should be notified immediately, and transformer should be loaded only after the written approval of the person in charge.

Every transformer dispatched to site should be entered individually in store register. This register should have the following:



- (i) Sl. No.
- (ii) Date of receipt
- (iii) Transformer capacity (kVA)
- (iv) Manufacturer's name
- (v) Date of Despatch to site
- (vi) Name of site

Transformers should be lifted using the lifting lugs provided on the transformer tank and the lifting arrangement should not cause unbalance of the transformer. Before lifting the complete transformer, it should be ensured that all cover bolts are tightened. The slings, lifting tackle, etc. to be used in hoisting of transformers should have adequate strength to handle the weight.

During transport of transformers, they should be rigidly secured to the transport vehicle and packing material put on either side of the base of the transformer to prevent skidding. A responsible official shall supervise the loading. Rollers, if provided, should be removed.

Care should be taken in transporting transformers to site to prevent the transformers moving when going up and down hills and around corners.

The transformer should be brought just adjacent to the double pole structure for hoisting it on the transformer platform. Lifting tackle should be used for hoisting transformer on the structure.

In case, it is not possible to bring the vehicle carrying transformer near the double pole structure, it should be unloaded at a nearest safe place and carried to the double pole structure manually with great care and under proper supervision or shifted on platforms fitted with rollers.

While hoisting transformers on the transformer platform, safety precautions by way of fixing additional clamps and bolts should be taken. Readymade slings to suit the capacity of transformer should be available.

5.10 Protection of Distribution Transformers

The pole mounted distribution substation arrangement has been standardised to the extent possible with the structure and the high voltage connections being identical for all transformer sizes. Dropout fuses are provided on H.V side of the transformer for isolating and protection. The size of fuse link used in these drop out fuses will vary with transformer rating. Acceptable fuse link sizes for BPC's existing transformer capacities are given in table 100 below: For transformers located at the remote end of rural feeders, where the short circuit levels are potentially low, fuse links at the lower end of the allowable range should be used.

Table 100: Acceptable Transformer Medium Voltage Fuse Link Ratings

MV Rating (kV)	Phases	Capacity (kVA)	Rated Current (A)	Fuse Link (A)
33	3	25	0.44	1 to 2
33	3	63	1.1	2 to 4

33	3	125	2.2	4 to 8
33	3	250	4.4	9 to 16
33	3	315	5.51	10 to 20
33	3	500	8.7	16 to 32
33	1	16	0.5	1 to 2
33	1	25	0.8	1 to 2
11	3	16	0.8	1 to 2
11	3	25	1.3	2 to 4
11	3	63	3.3	7 to 9
11	3	125	6.6	15 to 30
11	3	250	13.1	25 to 50
11	3	315	16.5	32 to 40
11	3	500	26.24	65 to 100
11	3	750	39.36	80 to 100
11	1	10	0.9	2 to 3
11	1	16	1.5	3 to 7

On the low voltage side of the transformer the supply cable is run into a 4-way feeder cubicle mounted on the transformer structure. The cubicle's incoming cable is terminated into a circuit breaker which can be used to offload the transformer. Three pole moulded case circuit breakers (MCCBs) shall be used for transformer sizes up to and including 315 kVA. Air circuit breakers may be used for larger transformers.

Circuit breakers shall comply with the requirements of IEC 60947-2 and shall be of the air break, quick make, quick break, trip free type, and fitted with electronic overcurrent, earth fault and short circuit protection. This protection shall not require an external power supply. The elements shall be adjustable so that adjustments are made simultaneously on all poles from a common adjustment control. The minimum interrupting current shall be 10 kA for transformers rated up to 250 kVA and 25 kA for larger transformers. When commissioning the transformer the MCCB overload shall be adjusted to be consistent with the full load transformer current as shown in table 101.

The size of the LV cable between the transformer and the feeder cubicle will depend on the size of the transformer, and is given in the following table 101. For non-standard intermediate size transformers the cable rating for the next size should be used. The table assumes that all cables up to 400 mm² are PVC insulated. The 630 mm² cable used on the 1,250 kVA transformer must be XLPE insulated in order to have the required rating.

Table 101: Low voltage cable ratings used between transformer and DP

Phases	Transformer Rating (kVA)	Maximum LV Current (A)	LV Cable Size (mm ²)
3	10	14	16

3	16	22	16
3	25	35	16
3	63	88	35
3	125	174	150
3	250	348	300
3	500	696	2 x 300
3	1,250	1740	2 x 630 ¹
1	10	42	16
1	16	67	25
1	25	104	35

Note 1 Must be single core XLPE insulated cable.

MCCBs may be used to protect outgoing distribution circuits in urban areas. As for incoming circuit breakers, the minimum interrupting current shall be 10 kA for transformers rated up to 250 kVA and 25 kA for larger transformers. Whereas the incoming MCCB is set in accordance with the transformer size, the setting of the outgoing MCCBs should be determined by the size of the cable being protected. The maximum MCCB setting if used for outgoing circuits is given in table 102. In order to obtain protection discrimination, outgoing MCCB current settings should be lower than the incomer, even if this is less than the rating of the outgoing cable.

Table 102: Max. MCCB Ratings for Three Phase Low Voltage Aluminium Cable Circuits

Cable Size (mm ²)	Maximum MCCB current rating ¹
16	63
25	100
35	160
150	250
300	630
630	1250

Note 1: This is the same as the cable rating given in table 101.

For low rating distribution substations the outgoing low voltage circuits will be ABC. These circuits shall be protected by fuses rather than MCCBs. Fuses shall be high rupturing capacity fuses with cartridge type links manufactured in accordance with IEC 60269-1. The fuse link rating shall be in accordance with table 103 below.

Table 103: Maximum Fuse Link Sizes for ABC Cable

Cable Size (mm ²)	Maximum Fuse Link Size (A)
50mm ² ABC	160
95 mm ² ABC	250



5.11 General Requirement of Distribution Boards

Distribution boards are used to connect customer service cables to distribution cables in underground or overhead systems. The pillar shall be sheet steel, robust, dust, weather and vermin proof, providing a degree of protection of IP 52 for indoor use and IP 54 for outdoor use. Sheet steel used shall be cold rolled, of minimum thickness 2.5 mm, smooth finished and appropriately stiffened to provide adequate strength. There shall be a removable gland plate of minimum 3 mm thickness. The distribution board shall have hinged doors with pad locking facility. Doors and other covers shall be fitted with neoprene gaskets, to satisfy the IP 52 and IP 54 requirements, to prevent ingress of dust, moisture and vermin.

All live parts shall have a minimum phase to phase and phase to earth clearance in air of 25 mm and 20 mm respectively. The removable cable gland plate of 2.5 mm cold rolled sheet steel is included. The interior cabling space is to be as per drawings. Requirements include an external earthing terminal suitable for 19 mm x 6 mm aluminium alloy earthing strip. Provide one number of HRC fuse puller for every distribution board.

The distribution board shall be provided with individual labels with designation or rating. The danger plate, as shown in the drawing, shall be fixed to every pillar door. All labels and plates shall be of corrosion resistant material. Distribution board can be categorized into three types as given in section 4.16.

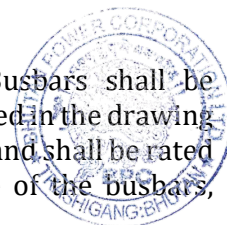
Pole mounted transformers rated 125 kVA and below shall have the distribution board fixed on the pole or mounting platform. The board shall be supplied complete with a hot dipped galvanised steel fixing assembly, to allow the board to be mounted on one transformer station steel pole, at a height approximately 1200 mm above ground level. Fixing assembly is to fix to poles of diameters ranging from 120 to 300mm. large size distribution boards shall be plinth mounted near the substation. The components of transformer distribution boards are:

- **MCCBs and HRC Fuse**

MCCBs shall be heavy duty type, mounted on bases, having a rupturing capacity of 10kA for transformers rated at 250kVA and 25kA for larger transformers. Outgoing feeders shall be protected by HRC Cartridge Fuse of appropriate capacity of the distribution pillar. The minimum rated breaking capacity of outgoing HRC fuse shall not be below 50kA.

- **Main Busbars**

Main busbars shall be of aluminium of appropriate size. Busbars shall be horizontal, but with gradual gradient from front to rear as indicated in the drawing for the different phases. All busbars shall be solid, without joints and shall be rated for continuous maximum current. The maximum temperature of the busbars,



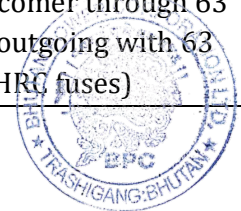
under operating conditions when carrying rated normal current, shall not exceed 85°C. Busbars shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current. Busbar support insulators shall conform to the relevant applicable Standard. Busbars shall not be painted and all performance characteristics specified shall be obtained with unpainted. The main busbar terminating to MCCB shall be with copper of appropriate current rating. Aluminium is not acceptable due to present construction issues where the size of aluminium bar has been reduced at MCCB terminal point to fit in MCCB slot, which gets burnt out over the time due to its reduced bar size.

- **Interior Lighting and Wiring**

Large transformer distribution board shall be provided with two 230V, 50 Hz, 40W, incandescent lamp fixtures, placed diagonally opposite each other, internally at the top of the pillar, for interior illumination and controlled by limit door switch and 2A fuse link. Whereas for small size pillars, one lamp fixtures controlled by limit door switch is sufficient.

Table 104: Distribution Board Rating for Pole Mounted Transformer

Phase	Transformer Rating (kVA)	LV Current (A)	DB Specification
3	10	13.91	TPN DB with 100 amps Bus bar, incomer through 63 amps TP MCCB, 2ways/4ways outgoing with 63amps HRC fuse (6HRC fuses/12HRC fuses)
3	16	22.26	TPN DB with 100 amps Bus bar, incomer through 63 amps TP MCCB, 2ways/4ways outgoing with 63amps HRC fuse (6HRC fuses/12HRC fuses)
3	25	34.78	TPN DB with 100 amps Bus bar, incomer through 63 amps TP MCCB, 2ways/4ways outgoing with 63amps HRC fuse (6HRC fuses/12HRC fuses)
3	63	87.65	TPN DB with 200 amps Bus bar, incomer through 160 amps TP MCCB, 4ways outgoing with 100amps HRC fuse (12HRC fuse)
3	125	173.91	TPN DB with 300 amps Bus bar, incomer through 250 amps TP MCCB, 4ways outgoing with 200 amps HRC fuse (12HRC fuse)
1	10	41.67	SPN with 100 amps Bus bar, incomer through 63 amps SP MCCB, 2ways/3ways outgoing with 63 amps HRC fuse (2HRC fuses/3HRC fuses)



1	16	66.67	SPN with 100 amps Bus bar, incomer through 100 amps SP MCCB, 2ways/3ways outgoing with 100amps HRC fuse (2HRC fuses/3HRC fuses)
1	25	104.7	SPN with 200 amps Bus bar, incomer through 160 amps SP MCCB, 3ways outgoing with 100amps HRC fuse (3HRC fuses)

Transformer Distribution boards for rural network will require 2 spare fuse for connection to new upcoming households.

Table 105: LV Distribution Board Specification for Pad Mounted Transformer

Phase	Transformer Rating (kVA)	LV Current (A)	DP Specification
3	250	347.80	TPN DP with 400 amps Bus bar, 4ways outgoing with 400 amps HRC fuse (12HRC fuse)
3	315	438.23	TPN DP with 630 amps Bus bar, 6ways outgoing with 500 amps HRC fuse (18HRC fuse)
3	500	695.60	TPN DP with 800 amps Bus bar, 6ways outgoing with 800 amps HRC fuse (18HRC fuse)

Mini Feeder Pillars are used for feeding consumers from Ring /Loop networks. Therefore a mini feeder pillar doesn't have incoming MCCB and outgoing HRC fuse protection. Mini feeder pillar comes with aluminum bus bars with nuts and bolts to connect cable lugs of different sizes. Mini feeder pillar shall also have interior lighting facilities similar to transformer distribution pillar. They shall have a degree of protection of IP 55 or better with bottom cable entry to avoid water ingress. The minimum panel thickness shall be 2.5 mm, and there shall be a removable gland plate of minimum 3 mm thickness. There shall be a lockable hinged door with a minimum thickness of 2 mm. Separate aluminium phase and neutral busbars shall be provided.

5.12 Connection of supply to consumer's premises

Supply to consumer premises through a 2 or 4 core overhead cable in situations where consumers are fed from the overhead system and a 2 or 4 core underground cable when fed from an urban underground system.

Drawing DDGS-BPC-2023-36 shows the connection arrangement for a three phase and single phase consumers. All components except the energy meter shall be provided by the consumer. The energy meter will be provided by BPC.

A new connection should not be lived unless:



- The consumer has installed an MCB as a point of isolation;
- The consumer has installed a stake earth, which is connected to a main earth terminal on the consumer's distribution board;
- There is a link between the earth terminal and the incoming neutral. As shown in the drawing, the configuration of this connection will depend on connection of an ELCB/RCCB.

5.12.1 Consumer Metering

The choice of meter to install in a consumer installation will depend on the expected load. Three types of meter are available:

- Direct connected, where the meter is directly connected to the incoming low voltage supply;
- CT metering, where the meter is indirectly connected to the low voltage supply through a current transformer; and
- High voltage metering, where the consumer is supplied at high voltage and the meter is indirectly connected to the high voltage supply through a high voltage metering unit.

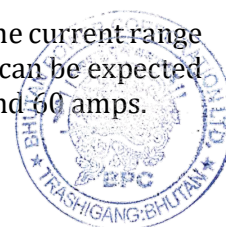
5.12.2 Direct Connected Metering

Direct connected metering should be used when the consumer load does not exceed 60 A. Standard direct connected meters used by BPC are given in Table.

Table 104: BPC Standard Direct Connected Meters

Phase	Meter Type	Capacity (A)	Class
1	Static	10-60Amps	2
3	Static	5-30Amps	2
	Static	10-80Amps	2

The class of meter indicates its accuracy and the meter capacity indicate the current range over which the accuracy can be assured. Hence a class 2 10/60 A meter can be expected to have a metering accuracy of 2% over a current range of between 10 and 60 amps.



5.12.3 CT Metering

Where the consumer is supplied at low voltage and the expected maximum three phase load is greater than 60 A, current transformer (CT) metering should be used. All current transformers have a 5 A output and feed into a standard 5 A, class 1 static meter. The load shown on the meter needs to be multiplied by the CT ratio to give the actual consumption.

CTs currently used by BPC have a ratio of 100/5, 200/5, 300/5, 400/5, and 500/5 and have an accuracy of class 1 and a burden of 15 VA.

Care must be taken to ensure the correct multiplier is used when measuring consumption using CT metering.

Table 105: BPC Standard CT Connected Meters

CT class	Meter Type	Capacity (A)	Class
X/5	Static	100/5Amps	1
	Static	200/5Amps	1
	Static	300/5Amps	1
	Static	400/5Amps	1

5.12.4 High Voltage Metering

Consumers supplied at high voltage must provide a high voltage metering unit acceptable to BPC. The high voltage metering unit shall incorporate both potential and current transformers. The current transformer shall be class 0.5s, have a maximum burden of 15 VA and have either a 1 A or 5 A output. The voltage transformer shall be class 0.5, have a maximum burden of 15 VA and have a 110 V output.

BPC will connect its own class 0.5 trivector electronic meter meeting the requirements of IEC 60687 to the consumer's high voltage metering unit. The meter shall incorporate a data logging facility and be capable of recording a range of different power system parameters at the point of connection.

5.13 Underground Cable Installation

5.13.1 General

- These notes in general cover cables upto and including 33 kV rating.



- Electrical installation work shall comply with all currently applicable statutes, regulations and safety codes in the locality/country where the installation is to be carried out.
- Installation of cables shall be carried out generally as per IS 1255 or relevant applicable IEC standards and enclosed typical drawings.
- Installation of cables shall include unloading, storing, laying, fixing, jointing, termination and all other work necessary for completing the job. Supply of glands and lugs whenever specified, together with necessary materials for jointing and termination shall also be included in Contractor's scope.
- Construction of cable trenches, provision of embedment and similar work involving civil items will be carried out as per the instructions/notes on the respective project drawings and installation specification.
- Cables will be installed in trenches, trays, racks, tunnels, conduits, duct banks or directly buried. The actual cable layouts will be shown on the relevant drawings. Any changes, if necessary, after obtaining prior approval of the Engineer shall be carried out at site by the Contractor and shall be clearly marked by him on drawings.
- Cables to each circuit shall be laid in one continuous length.
- Where cables are to be installed at temperatures below 3 ° C, they shall be heated to about 10 ° C for not less than 24 hours (in a heated building or in a tent with hot air heater) to facilitate laying (otherwise the bending would damage the insulation and protective coverings of cables). The cable laying must be carried out swiftly so as not to allow the cable to cool down too much.
- Instead of cast iron cable route marker, plastic marking tape may be used for UG which shall run along the length of the cable and shall have cable marking at every 1.5meter length.

5.13.2 Outdoor Cable Installation

- Directly buried cables shall be laid as per the drawings and cable route markers shall be provided. MS cable marker to be replaced by plastic marker buried cables in trefoil formation shall be bound by plastic tapes or 3mm dia. nylon core every 750 mm.
- Joints in directly buried cables shall be identified by joint markers at each joint location.
- In each outdoor cable run greater than 50 metre, some extra cable length shall be kept at a suitable point to enable a straight through joint to be made should the cable develop fault at a later date.
- Where cables cross roads, water or sewage pipes, the cable shall be laid in tube or steel pipes. For road crossings the pipe for the cable shall be buried at not less than



600 mm unless otherwise noted in the drawings. Hume pipes shall be preferred to steel pipes from the point of view of corrosion.

- Control cables and small power cables in trenches and tunnels shall be run in ladder type cable trays (maximum tray width 600 mm) supported on trench/tunnel carrier arms. The cables shall be laid to tray rungs by means of 3mm dia. nylon cord at an interval of 5000 mm and also at bends.
- For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls/slabs for passage of cables into a building from cable trays/racks/cable trenches located outside the buildings.

5.13.3 Bending Radii for Cables

The bending radii for various types of cables shall not be less than those specified below, unless specifically approved by the Engineer.

Description	Single Core	Multicored Armoured	Multicored Unarmoured
PVC insulated cable upto 11 kV	20 D	12 D	15 D

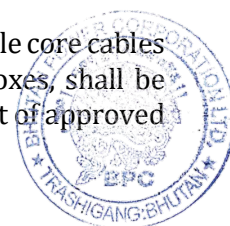
Where D = Overall diameter of cable.

(For XLPE insulated cables, recommendations of manufacturers to be followed).

The above values may be reduced to 70% when making only one bend such as in case of installing an end termination

5.13.4 Terminations Clamping & Miscellaneous Details

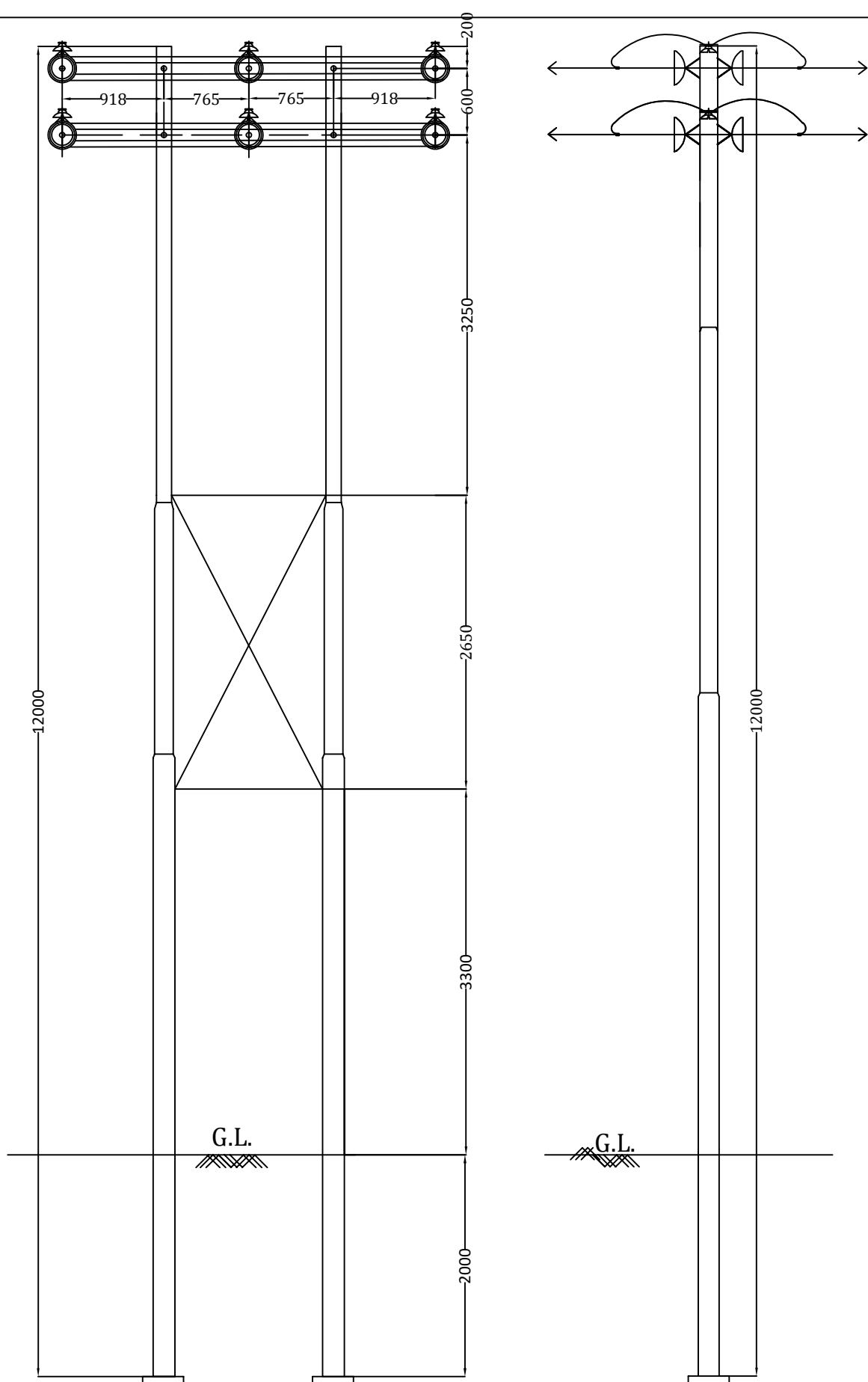
- Cable entry to motors, push button stations and other electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.
- Identification tags made from aluminium sheet shall be attached to each end of each cable by means of GI binding wire as shown in drawing. Tags shall be additionally put at an interval of 30 meters on long runs of cables and in pull boxes.
- All cable terminations shall be solderless crimping type. Whenever lugs are required to be supplied, adequate size crimping lugs of approved make shall be used by the Contractor. The crimping tools shall be adequate for the lug sizes.
- Wooden cleats when required for vertically supporting on or more single core cables per phase, such as on vertical framework near transformer cable boxes, shall be made out of well seasoned wood given two coats of fire retarding paint of approved quality.



5.13.5 Earthing of Cables

- Metallic sheaths, screens and armour of all multi-core cables shall be earthed at both equipment and switchgear end.
- Sheath and armour of single core power cables shall be earthed at switchgear end only. If specifically indicated in drawings, for long lengths of cables multiple earthing may have to be adopted to safeguard against the presence of standing voltage under normal as well as fault conditions.
- Earthing of CT and PT neutral lead shall be at one end only.





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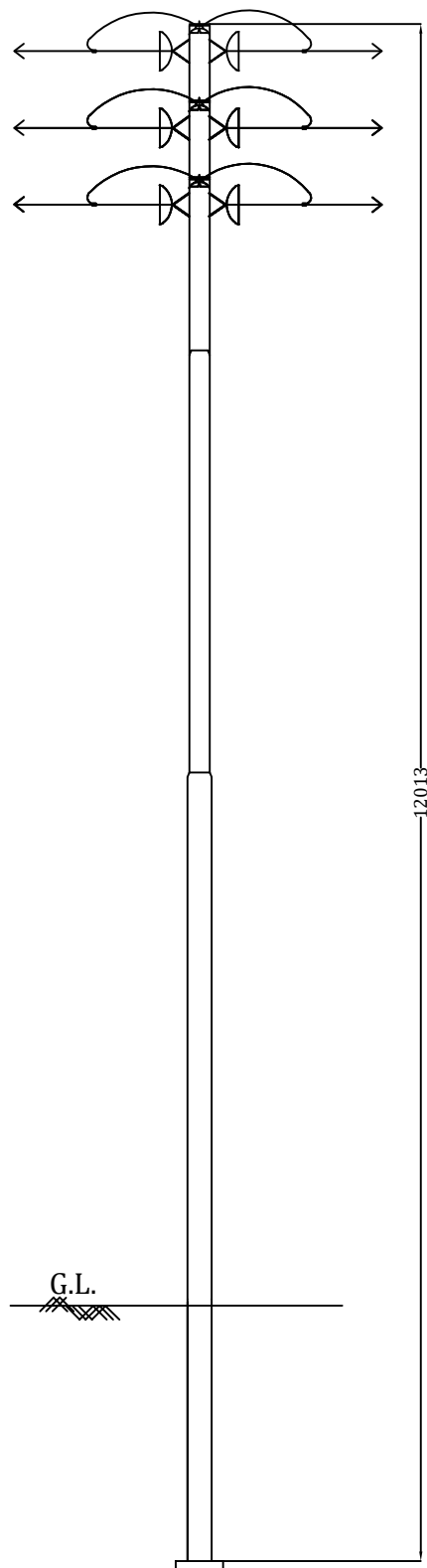
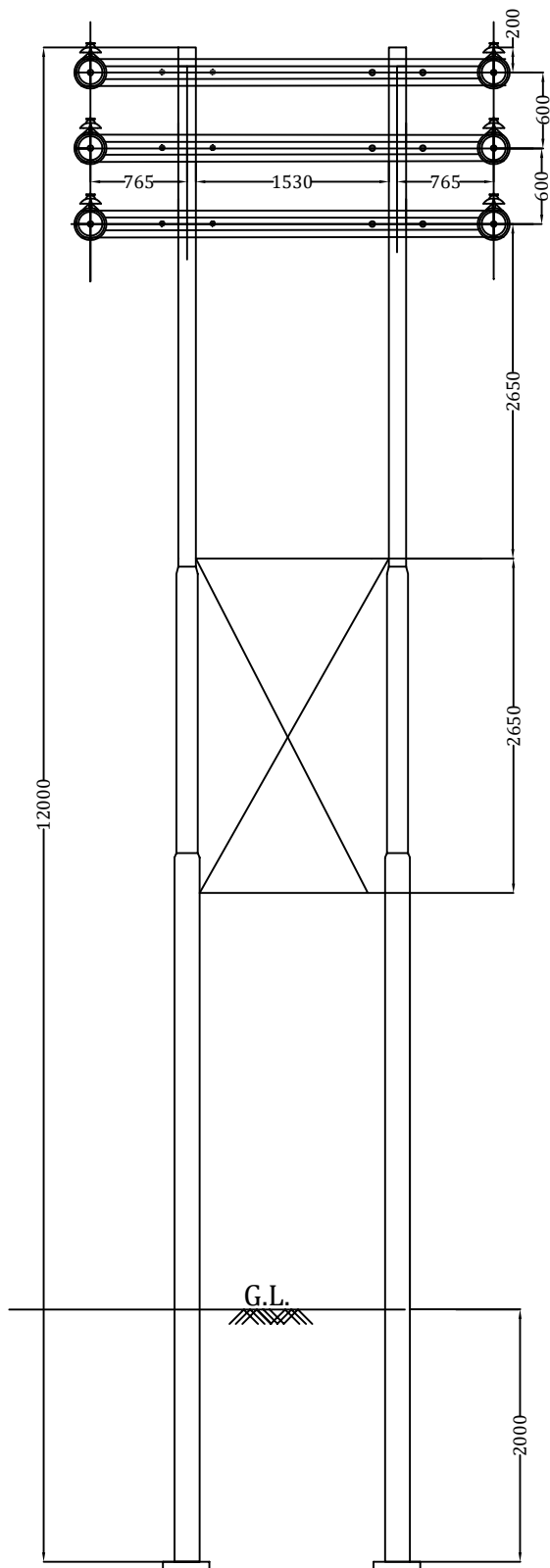
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**TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
11 kV, D - CKT, POLE STRUCTURE HORIZONTAL CONFIGURATION**

**DRAWING NO. BPC - DDCS -
2023-12/1-2**

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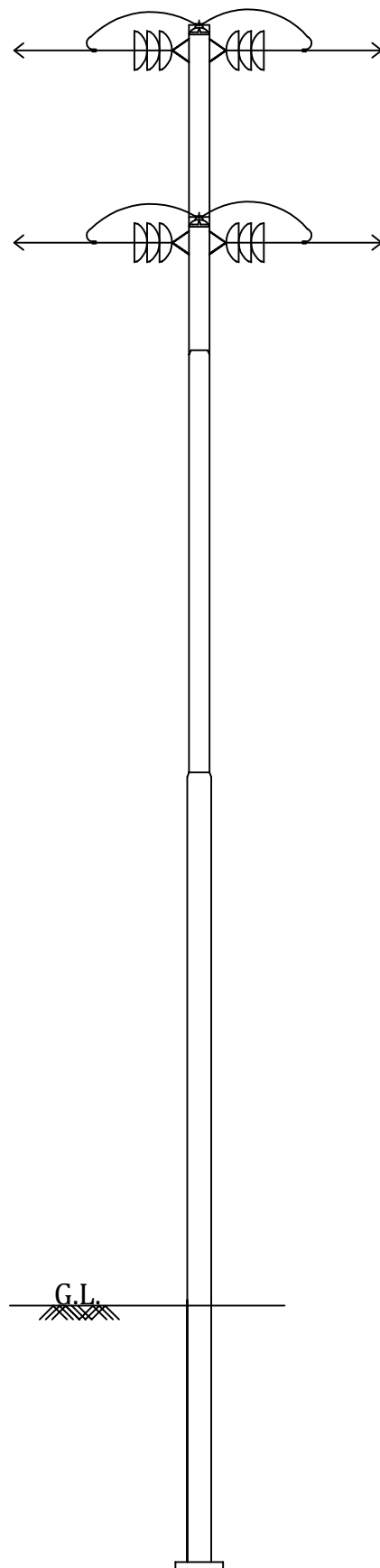
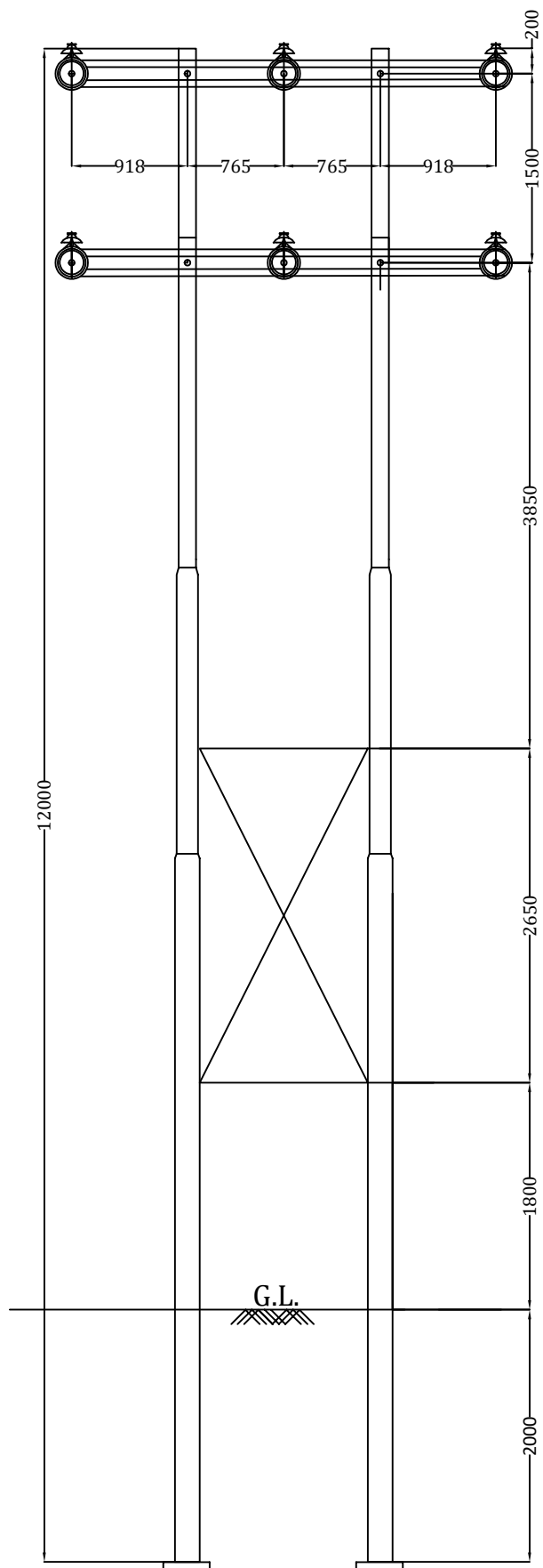
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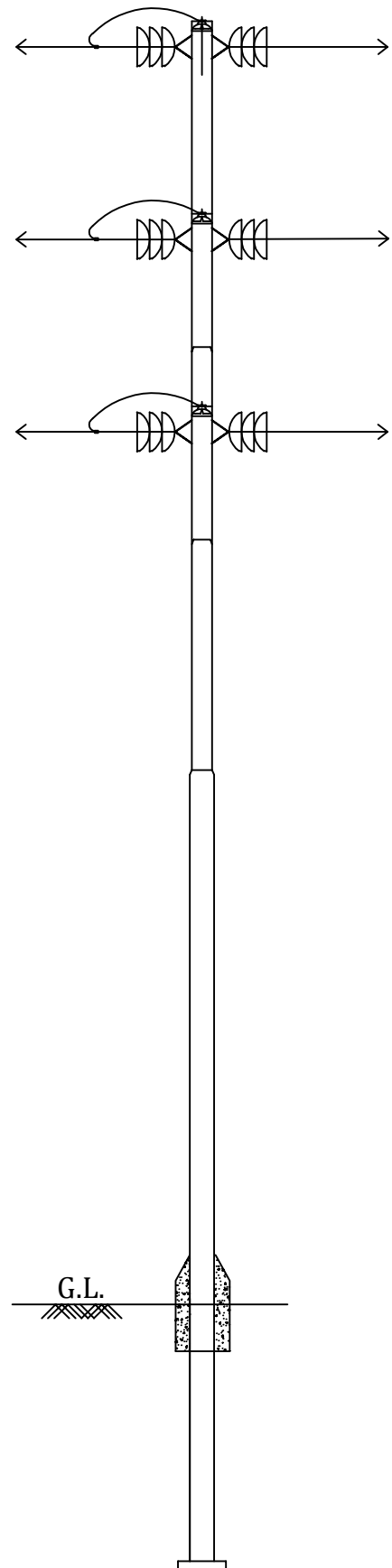
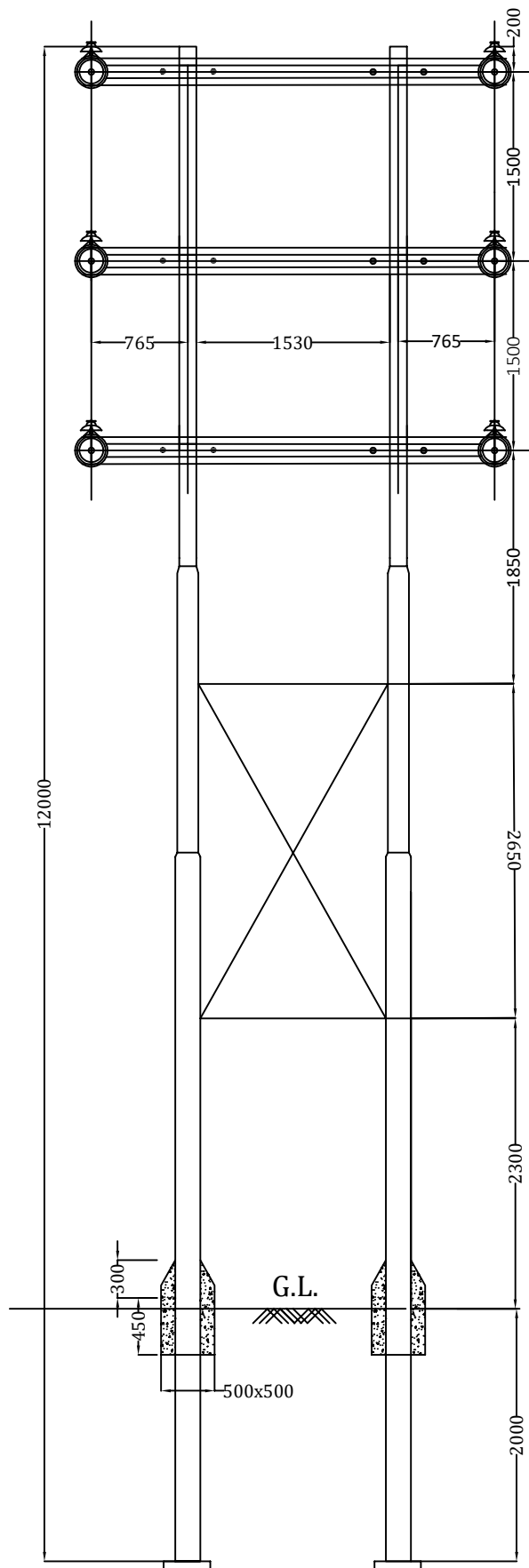
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33 kV, D - CKT, POLE STRUCTURE VERTICAL CONFIGURATION**

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NAME

DATE

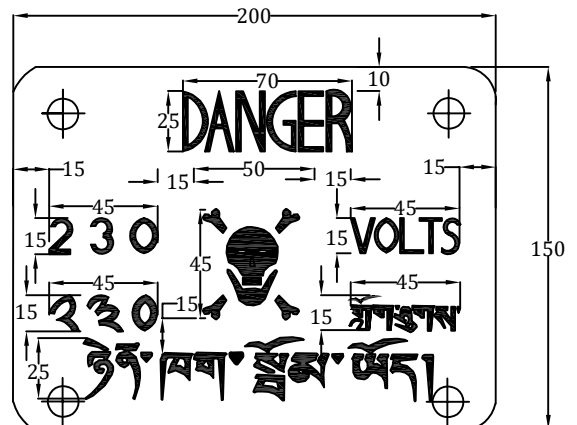
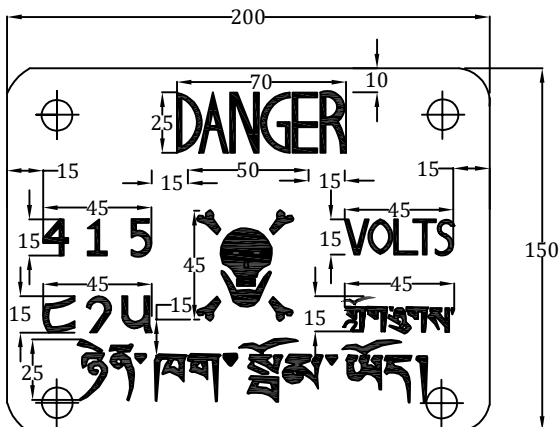
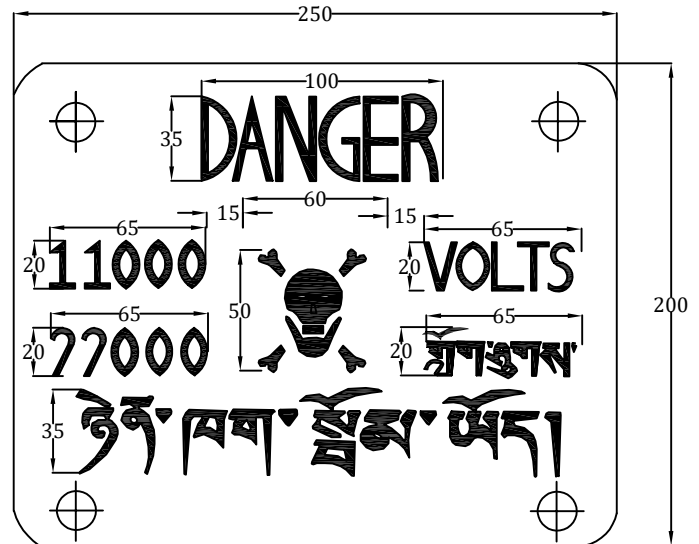
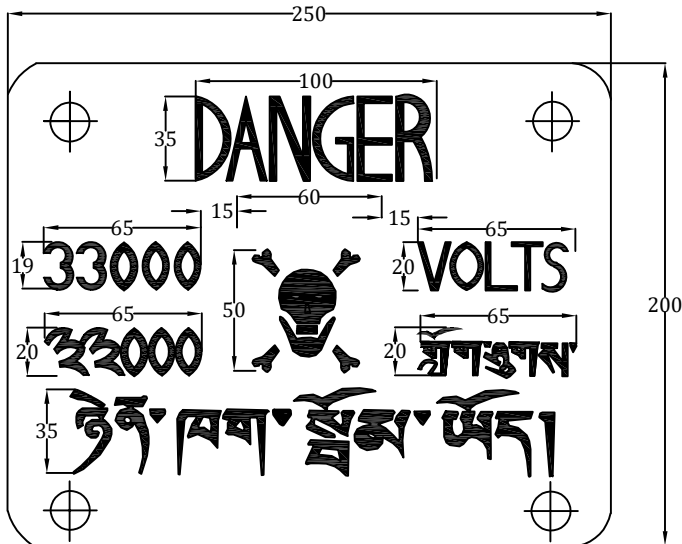
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1. DIMENSIONS AS SHOWN ARE IN MM
2. MS PLATE SHALL BE 2MM THICK
3. LETTERING AND FIGURE: RED ENAMELED
BACKGROUND: WHITE ENAMELED
BACK OF THE PLATE: BLACK ENAMELED
4. DESIGN OF DANGER PLATE IS AS PER IS: 2551
5. CORNERS OF THE PLATE SHALL BE ROUND OFF
6. FASTENERS PER PLATE: 4NOS. 16MM DIA WITH GI BOLTS
7. ONE DANGER PLATE PER STRUCTURE



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TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
DANGER PLATE

DESIGNED BY

NAME

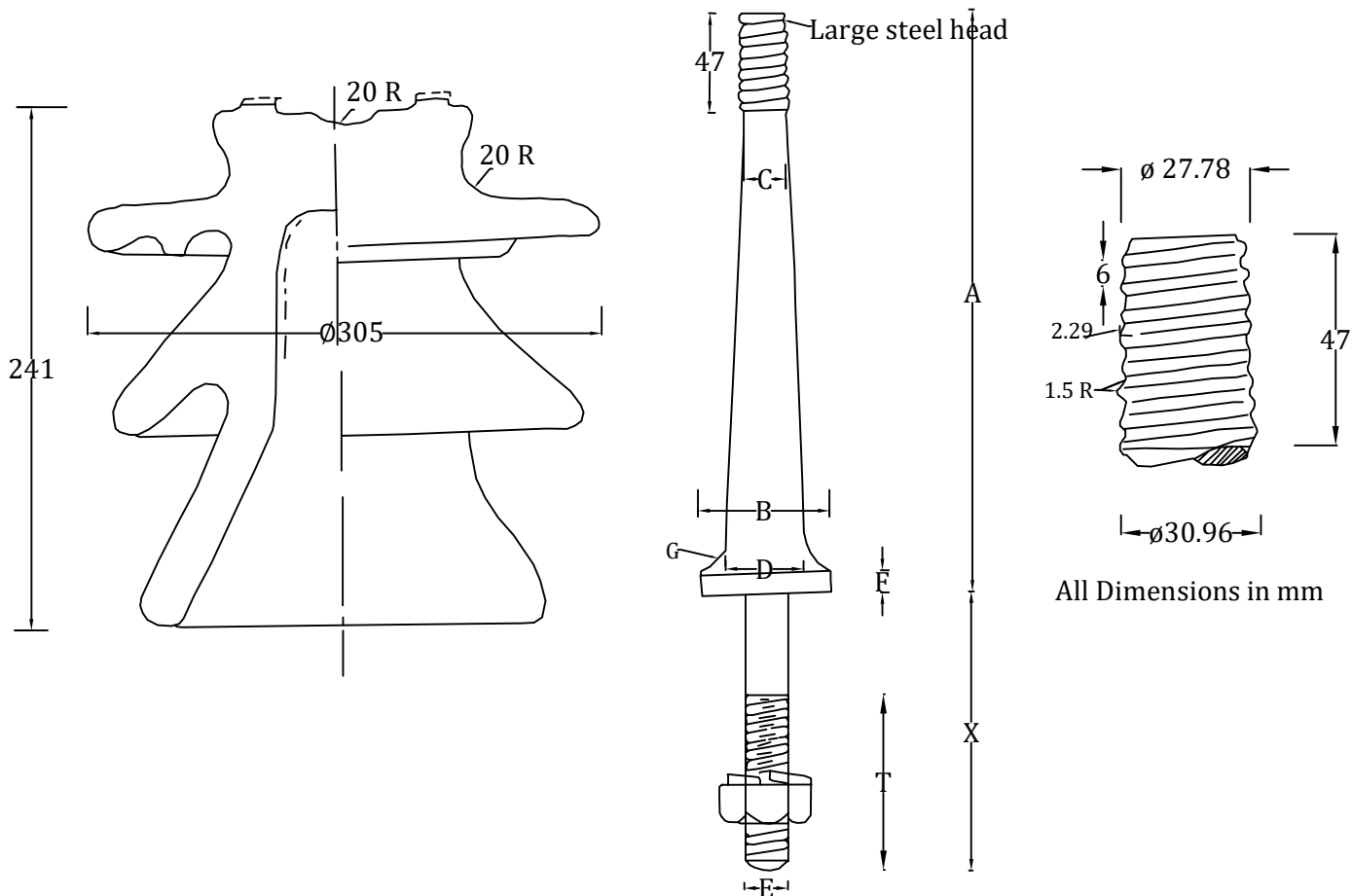
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Specification no. IS 2486 (Part II) 1974

A	B	C	D	E	F	G	T	X
mm	mm	mm	mm	mm	mm	mm	mm	mm
300	67	27	44	24	6	12	100	150

TECHNICAL DETAILS:

- (a) Highest System Voltage 36kV (rms)
- (b) Wet Power Frequency withstand Test 75kV (rms)
- (c) Power Frequency Puncture withstand Test 180kV (rms)
- (d) Impulse Voltage withstand Test 170kV (peak)
- (e) Minimum Failing Load 10kN

Large Steel Head Pin for 33kV Pin Insulator



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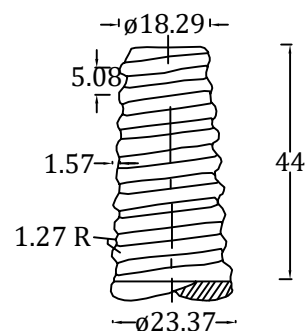
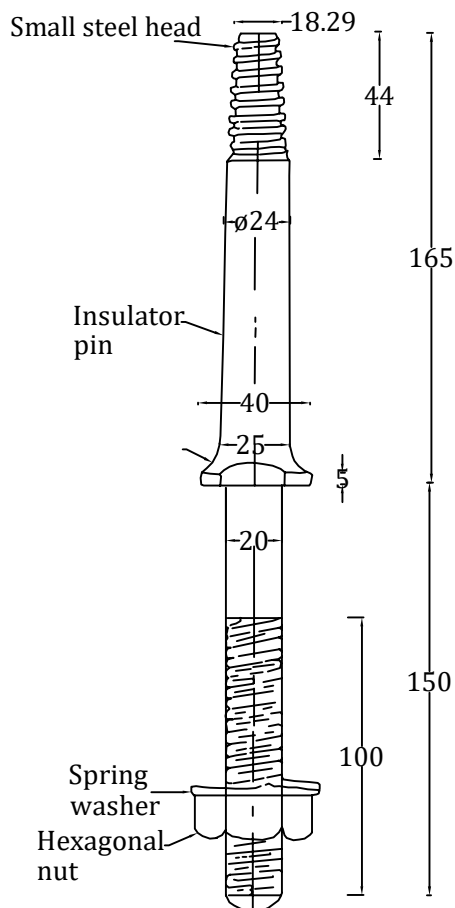
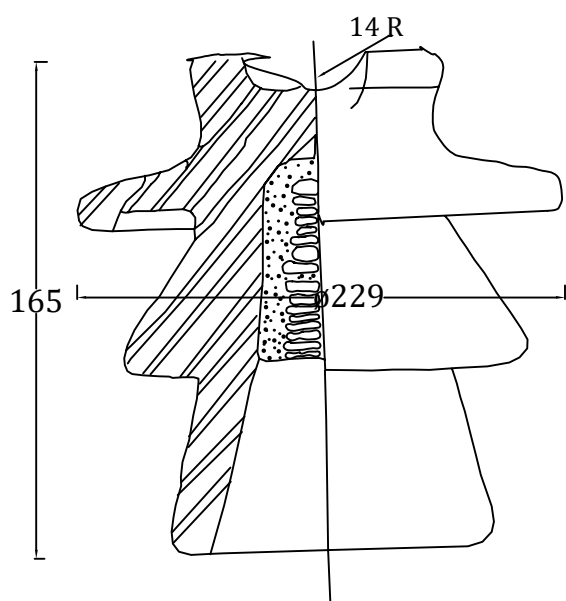
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TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
33kV - 10kN PIN INSULATOR- LARGE HEAD

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20/1-7

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DETAILS OF SMALL STEEL HEAD

Small Steel Head Pin for 11kV Pin Insulator

Note:

1. Specification no. IS 2486 (Part II)
2. All Dimensions in mm
3. Minimum Failing Load 5 kN



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ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
11kV - 5kN PIN INSULATOR- SMALL HEAD

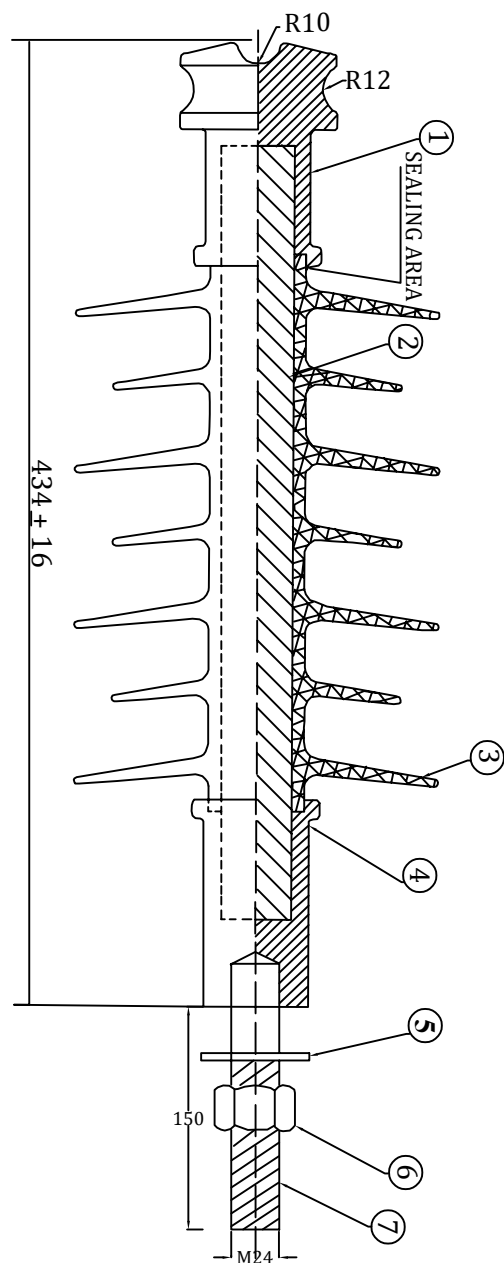
DRAWING NO. BPC - DDCS - 2023 -
20/2-7

REVISION
2023

DESIGNED BY
CHECKED BY
APPROVED BY

NAME

DATE



Sl.no	Description
1	Top Metal Fitting
2	Core Rod
3	Polymer Housing
4	Bottom Metal Fitting
5	Plain Washer
6	Nut
7	Stud

Guaranteed Technical Parameters

1. Min. Creepage Distance: 900 mm
2. Arcing Distance (Approximate) : 320 mm
3. Cantilever Failure Load : 10 kN
4. Nominal System Voltage : 33 kV
5. Highest System Voltage : 36 kV
6. System Frequency : 50 Hz
7. 1 Min. Power Freq. Withstand Voltage (Wet) : 75 kV (rms)
8. Dry Lightning Impulse Withstand Voltage : 170 kVp



BHUTAN POWER CORPORATION
LIMITED

ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
33kV & 11kV - 10kN COMPOSITE SILICON RUBBER PIN INSULATOR

DESIGNED BY

NAME

DATE

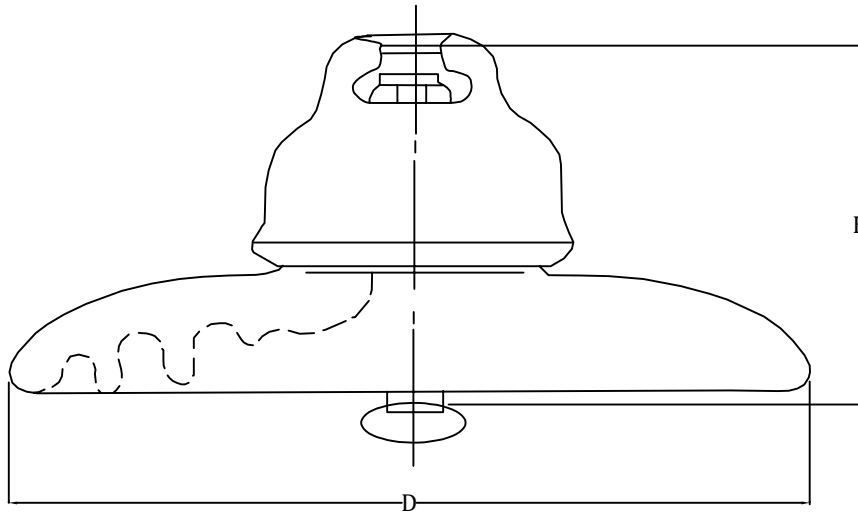
CHECKED BY

APPROVED BY

DRAWING NO. BPC - DDCS - 2023 -
20/3-7

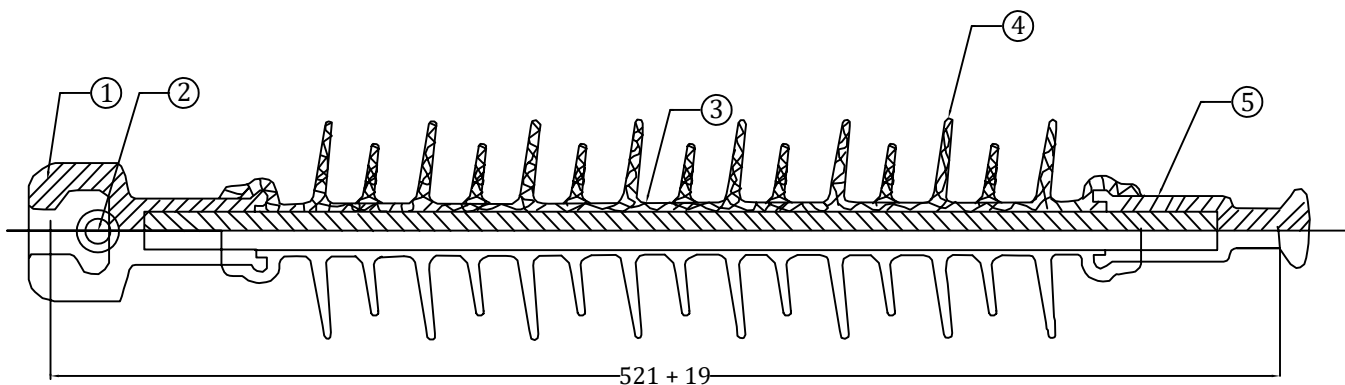
REVISION
2023

Porcelain Disc Insulator



Item	Dimensions (mm)		Rate Failure Load (kN)	Weight (kg)
	D	H		
11kV	255	146	70	5.2
33kV	255	146	70	5.2x3

33 kV&11 kV-70 kN COMPOSITE SILICONE RUBBER LONG ROD INSULATOR



Sl.no	Description
1	Socket Fitting
2	Security clip (R)
3	Core Rod
4	Polymer Housing
5	Ball fitting



**BHUTAN POWER CORPORATION
LIMITED**

ENGINEERING AND RESEARCH DIVISION

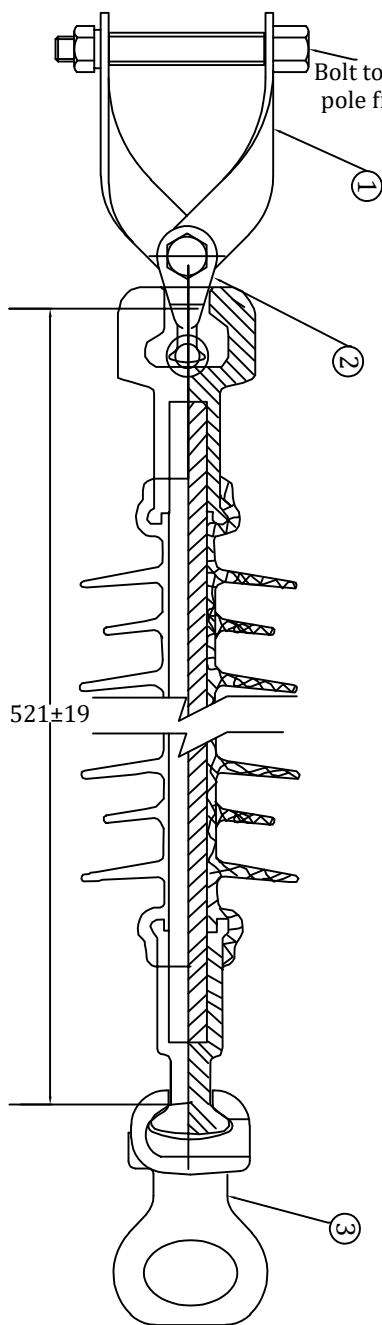
TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
PORCELAIN & COMPOSITE SILICON RUBBER DISC INSULATOR

DRAWING NO. BPC - DDCCS - 2023 -
20/4-7

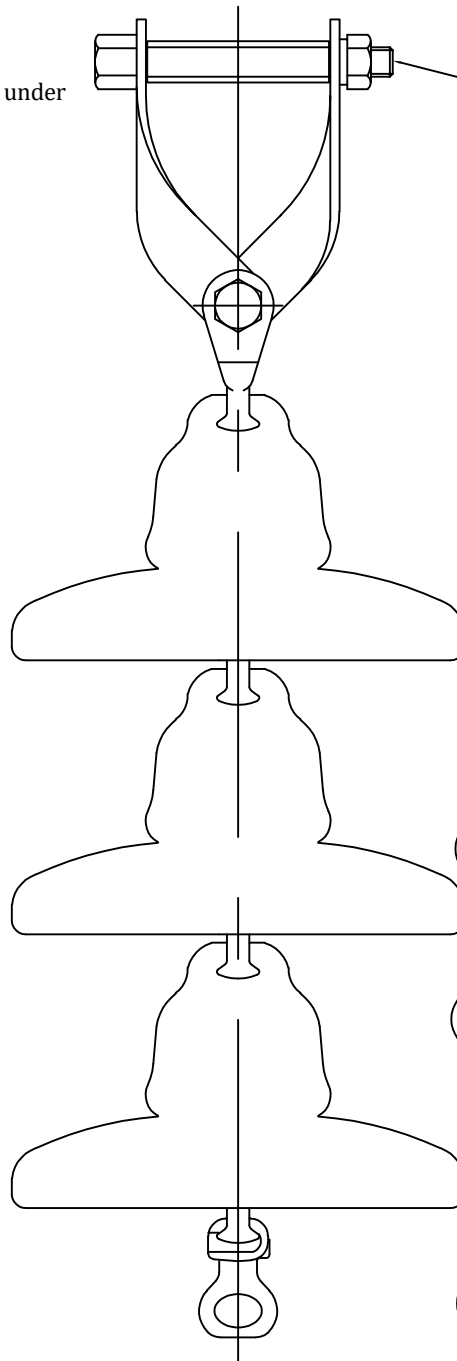
REVISION
2023

	NAME	DATE
DESIGNED BY		
CHECKED BY		
APPROVED BY		

SINGLE TENSION STRING

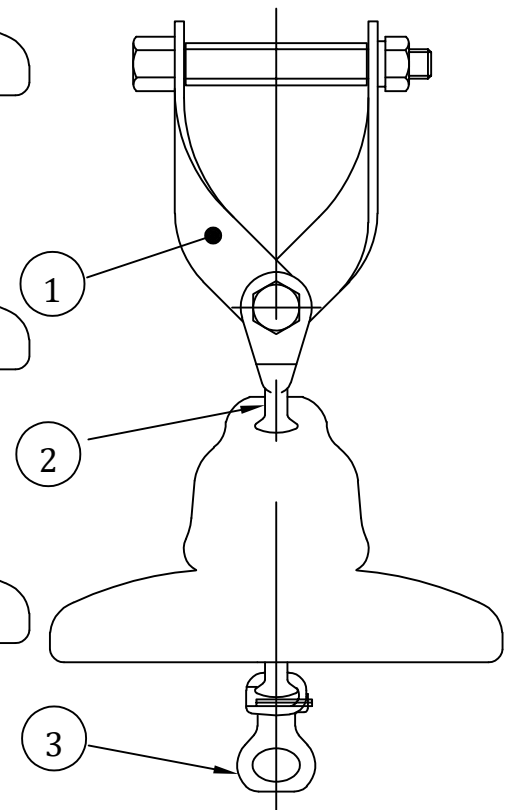


33 kV SINGLE TENSION STRING



Bolt to be supplied
under pole
fittings

11kV SINGLE TENSION STRING



Notes:

1. All fittings shall be galvanised according to relevant standard

3	SOCKET THIMBLE	1	ALUMINIUM ALLOY
2	BALL EYE	1	FORGED STEEL
1	CROSSARM STRAP (TOGETHER, NOT SEPARATE)	1	GALVANISED IRON
ITEM	NAME OF ITEM	QTY	MATERIAL



BHUTAN POWER CORPORATION
LIMITED

ENGINEERING AND RESEARCH DIVISION

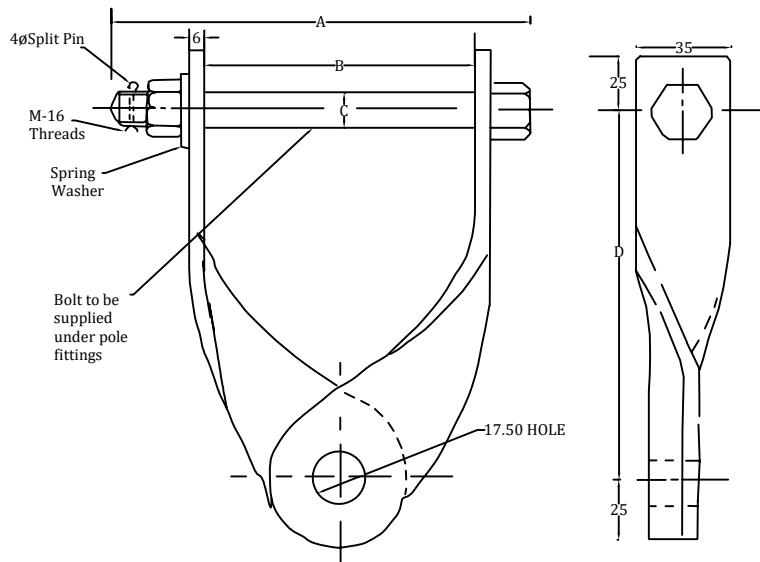
TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
ASSEMBLY FOR DISC INSULATOR ARRANGEMENT

DRAWING NO. BPC - DDCS - 2023 -
20/5-7

REVISION
2023

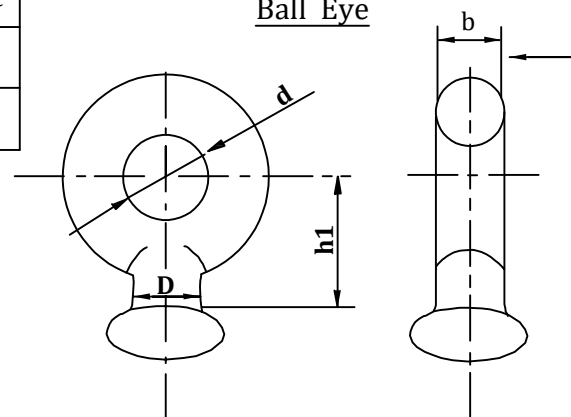
	NAME	DATE
DESIGNED BY		
CHECKED BY		
APPROVED BY		

CROSS ARM STRAP

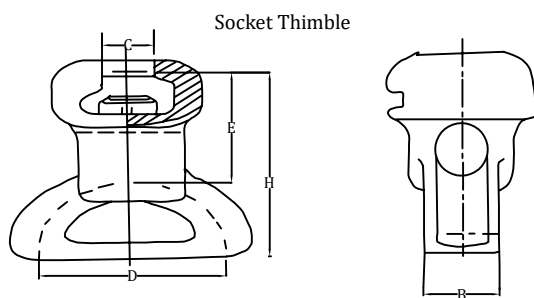


Dimensions (mm)				Rate Failure Load	Weight
A	B	C	D	(kN)	(kg)
150	100	16	140	70	-

Ball Eye



Dimensions (mm)				Rate Failure Load	Weight
D	h1	b	d	(kN)	(kg)
17	50	16	18	70	-



Dimensions (mm)					Rate Failure Load	Weight
B	C	D	E	H	(kN)	(kg)
32	17.6	60	60	95	70	1.20

Notes:

1. All fittings shall be galvanised according to relevant standard



BHUTAN POWER CORPORATION
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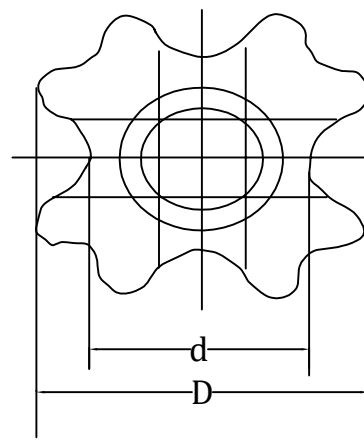
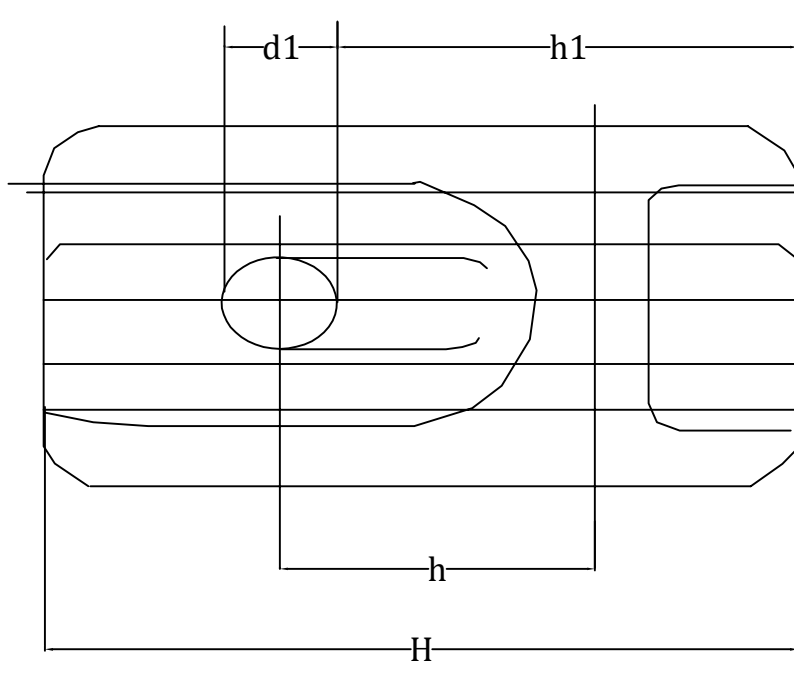
ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
HARDWARE FITTINGS FOR DISC INSULATOR ARRANGEMENT

DRAWING NO. BPC - DDCS - 2023 -
20/6-7

REVISION
2023

	NAME	DATE
DESIGNED BY		
CHECKED BY		
APPROVED BY		



Item	Dimensions (mm)						Rated Failure Load(kN)	Weight (kg)
	H	h	D	d	h1	d1		
11&33kV	140	80	85	60.3	114.3	25.4	89	1.95



BHUTAN POWER CORPORATION
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ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
HT STAY INSULATOR

DESIGNED BY

NAME

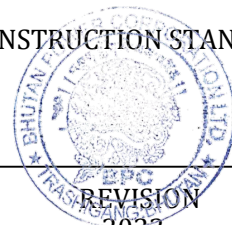
DATE

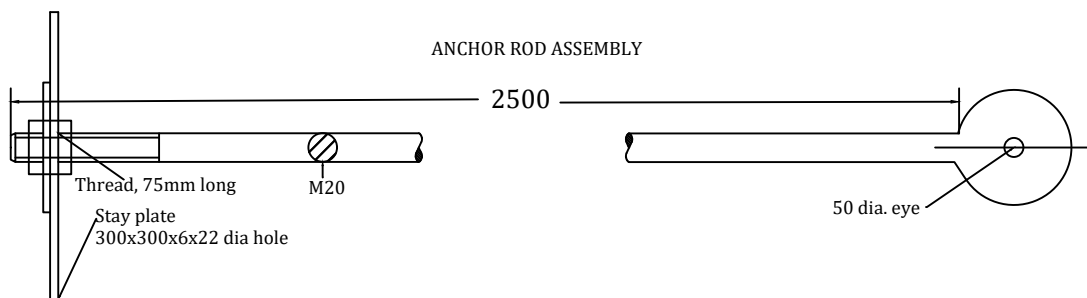
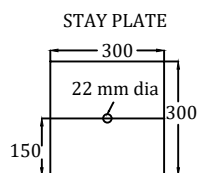
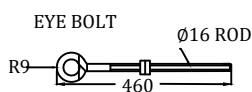
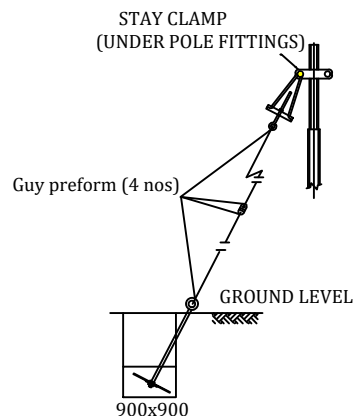
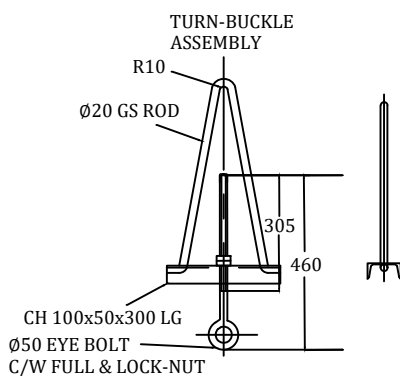
CHECKED BY

APPROVED BY

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20/7-7

REVISION
2023





NOTES

Stay rod and nuts assembled and packed together

Anchor plates packed separately

Material :- BS 4360 Grade 43A

Galvanizing :- BS 729

Threads :- ISO Metric

Nut :- BS 4190 Grade 4.0

STAY WIRE (7/8 SWG) (IN METERS)	1M+POLE HEIGHT	H.D.G STEEL
STAY ROD (2.5 M) WITH THIMBLE	1	H.D.G STEEL
ANCHOR PLATE (300 X 300 X 6MM)	1	H.D.G STEEL
TURN BUCKLE ASSEMBLY WITH THIMBLE	1	H.D.G STEEL
GUY PREFORMED SUITABLE FOR 7/8 SWG	4	GALVANISED STEEL WIRE
STAY INSULATOR	1	PORCELAIN
NAME OF THE ITEM	QTY	MATERIAL



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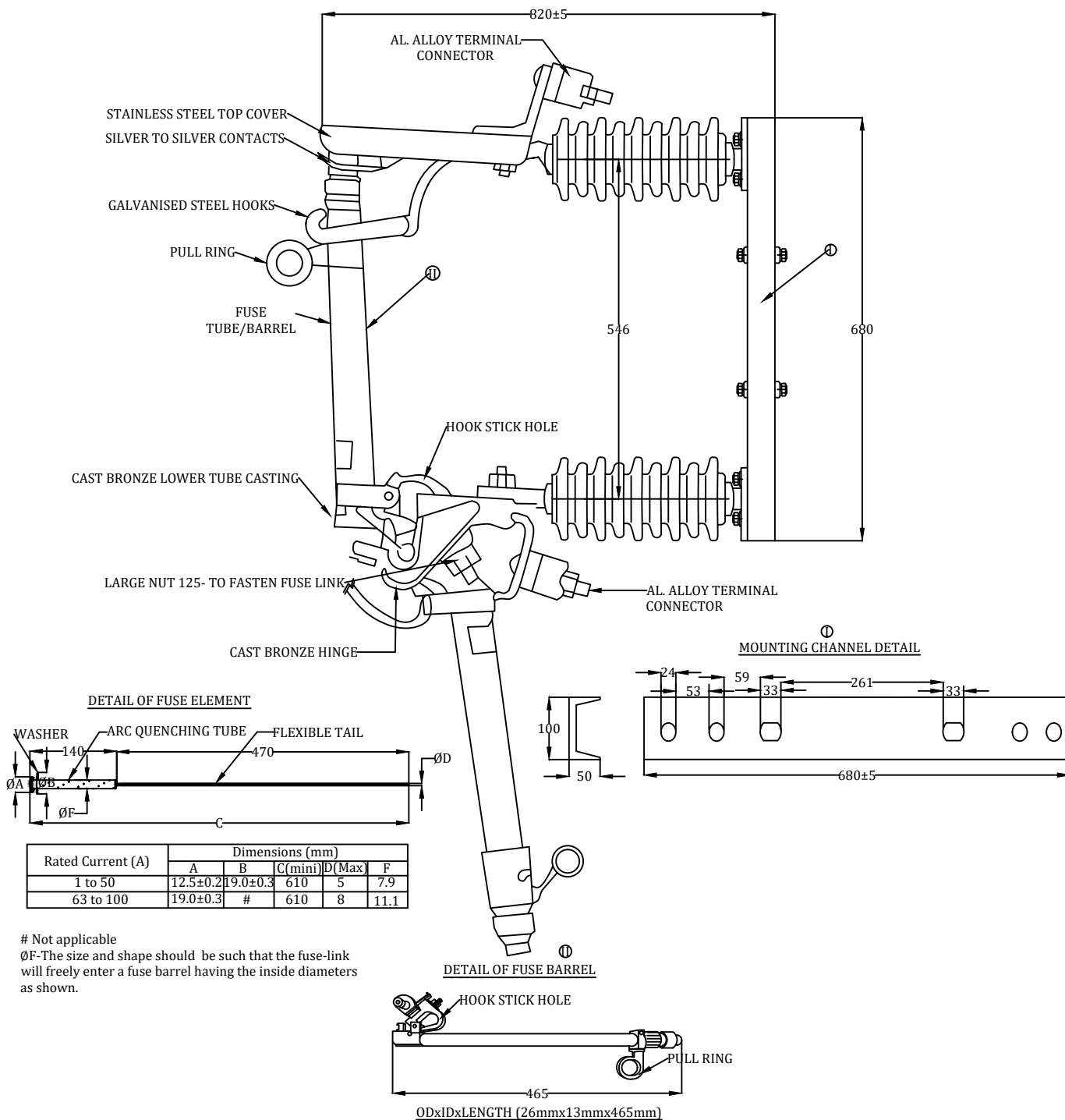
ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD

STAY SET ASSEMBLY FOR STEEL TUBULAR

DRAWING NO. BPC - DDCS - 2023 -
22/1-2

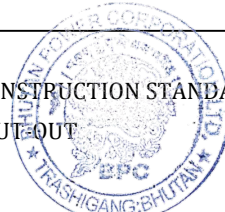
REVISION
2023



BHUTAN POWER CORPORATION
LIMITED

ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
DETAILS OF 11 KV AND 33 KV FUSE CUT-OUT



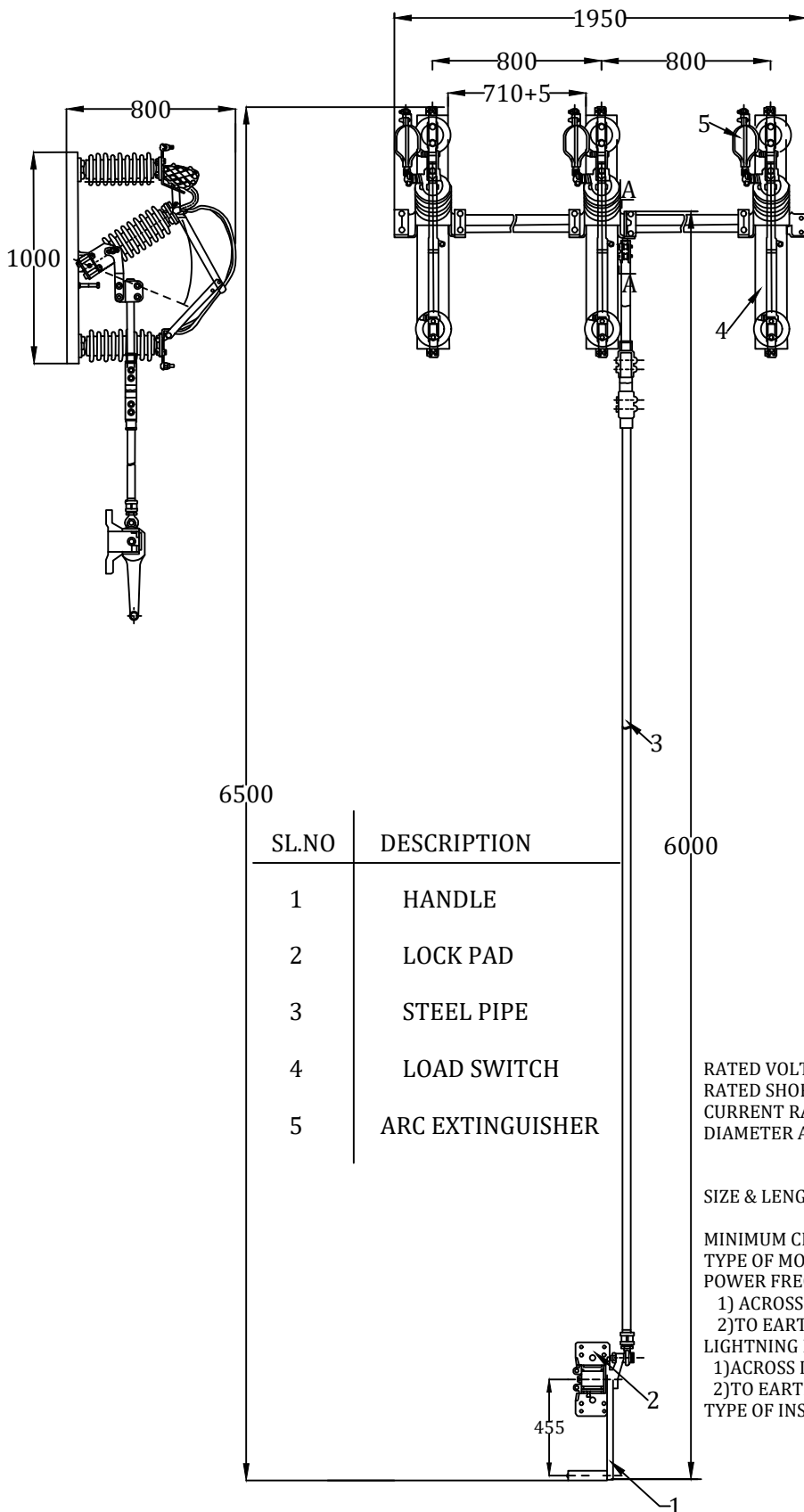
DRAWING NO. BPC - DDCS - 2023 - 28

REVISION
2023

DESIGNED BY
CHECKED BY
APPROVED BY

NAME

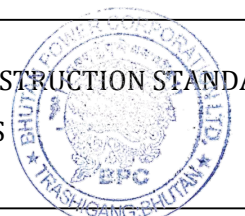
DATE



BHUTAN POWER CORPORATION
LIMITED

ENGINEERING AND RESEARCH DIVISION

TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
TYPICAL ARRANGEMENT OF 11kV LBS/ABS



DRAWING NO. BPC - DDCS - 2023 -
29A

REVISION
2023

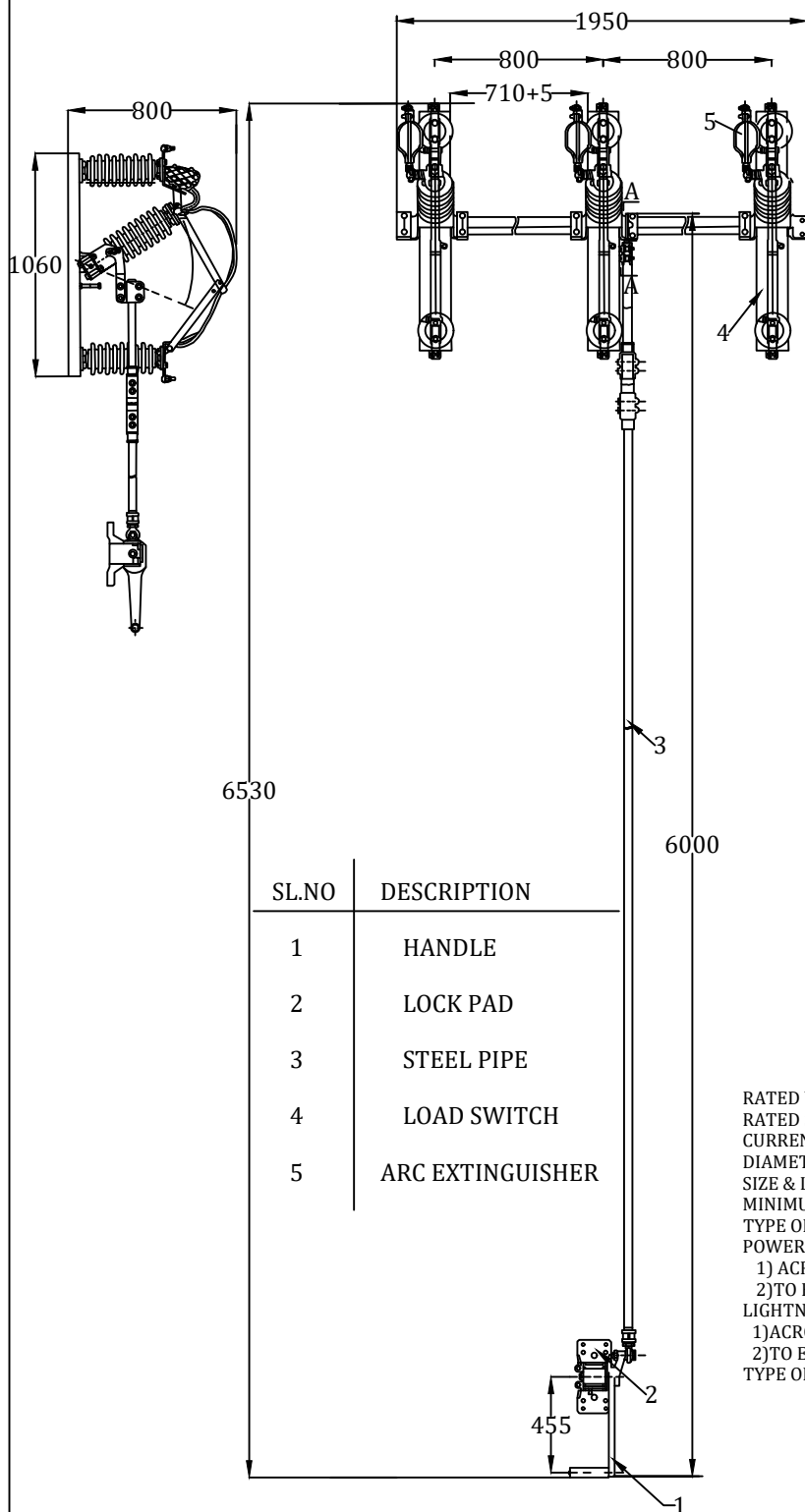
DESIGNED BY

CHECKED BY

APPROVED BY

NAME

DATE



6530

6000

SL.NO	DESCRIPTION
1	HANDLE
2	LOCK PAD
3	STEEL PIPE
4	LOAD SWITCH
5	ARC EXTINGUISHER

RATED VOLTAGE: 33kV
 RATED SHORT TIME WITHSTAND CURRENT FOR 3 SEC. 16kA
 CURRENT RATING: 630A
 DIAMETER AND LENGTH OF THE GI OPERATING PIPE 32MM x 6 METERS LENGTH
 SIZE & LENGTH OF THE CHANNEL FOR MOUNTING 75MM x 40MM x 1060MM LONG
 MINIMUM CLEARANCES BETWEEN PHASES 800MM
 TYPE OF MOUNTING VERTICAL
 POWER FREQUENCY WITHSTAND VOLTAGE
 1) ACROSS ISOLATING DISTANCE 80kV
 2) TO EARTH AND BETWEEN POLES 70kV
 LIGHTNING IMPULSE WITHSTAND VOLTAGE
 1) ACROSS ISOLATING DISTANCE 195kV
 2) TO EARTH AND BETWEEN POLES 170kV
 TYPE OF INSULATOR POST TYPE WITH ALTERNATING SHED



**BHUTAN POWER CORPORATION
LIMITED**

ENGINEERING AND RESEARCH DIVISION

**TITLE: DISTRIBUTION DESIGN & CONSTRUCTION STANDARD
TYPICAL ARRANGEMENT OF 33kV LBS/ABS**

	NAME	DATE
DESIGNED BY		
CHECKED BY		
APPROVED BY		

**DRAWING NO. BPC - DDCS - 2023 -
29B**

**REVISION
2023**



SECTION VII - CONTRACT FORMS

(Form No. 1 to Form No. 4)

Applicable Forms from this Contract Forms section shall either be submitted by the successful Bidder or by the Employer, post-award of Contract.

FORM 1: NOTIFICATION OF AWARD

[Insert date]

To: *[name and address of the Contractor]*

Sub: Notification of Award for

Ref: Our NIT No: *(insert number and reference of the NIT)*

Dear Sir or Madam,

With reference to your Bid dated *[insert date]* for the execution of the *[insert name of the Contract and identification number, as given in the SCC]* for the Contract Price of the equivalent of *[insert amount in numbers and words] [insert name of currency]*, as corrected and modified in accordance with the Instructions to Bidders is hereby accepted by our Agency.

[Insert one of the following (x) or (y) options if applicable]

- (x) We accept that *[insert name proposed by Bidder]* be appointed as the Adjudicator.
- (y) We do not accept that *[insert name proposed by Bidder]* be appointed as Arbitrator, and by sending a copy of this Notification of Award to *[insert name of the Appointing Authority]* we are hereby requesting *[insert name]*, the Appointing Authority, to appoint the Arbitrator in accordance with SCC 7.

The Contract in duplicate is attached hereto. Kindly be advised of the following:

- a) Please confirm your acceptance of this Notification of Award by signing and dating both copies of it, and returning one copy to us no later than 15 days from the date hereof;
- b) Please report to this office to sign the formal Contract Agreement within 15 (fifteen) days of the date of this Notification of Award.
- c) Prior to the signing of Contract Agreement, you are required to submit performance security in the form of a Bank Guarantee/demand draft/cash warrant as per ITB clause

42 and GCC clause 17. The performance security may be submitted in advance or at the time of signing the contract agreement. The bank guarantee/demand draft/cash warrant should be in favour of *(insert appropriate name and designation)*.

- d) The stipulated commencement of the work shall be reckoned from the date of Contract signing.

Kindly acknowledge the receipt of this letter.

Yours sincerely,

[xyz]

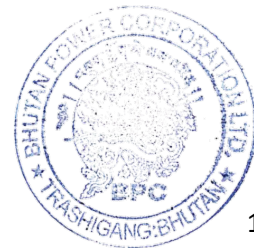
FORM 2: CONTRACT AGREEMENT

This agreement is made the *[insert day]* day of *[insert month]*, *[insert year]* between *[insert name and address of Employer]* (hereinafter called “the Employer”), of the one part, and *[insert name and address of Contractor]* (hereinafter called “the Contractor”) of the other part.

Whereas the Employer desires that the Contractor execute *[name and identification number of Contract]* (hereinafter called “the Works”) and the Employer has accepted the Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

The Employer and the Contractor agree as follows:

- a) In this Contract, words and expressions shall have the same meanings as are respectively assigned to them in the contract documents referred to.
- b) The following documents shall be deemed to form and be read and construed as part of this Agreement:
 - i. The Notification of Award
 - ii. The Bid Submission Form
 - iii. The addenda Nos. *(insert addenda number if any)*
 - iv. The General Conditions of Contract
 - v. The Special Conditions of the Contract
 - vi. The Technical Specifications
 - vii. The Drawings



viii. The Schedules

- c) In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.
- d) The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.
- e) This Agreement shall prevail over all other Contract documents.

In Witness whereof the parties thereto have caused this Agreement to be executed on the day, month, and year indicated above.

Sign & Seal of Contractor _____

Sign & Seal of a witness of Contractor: _____

Sign & seal of Employer authorized representative:

Binding signature of Employer's representative's signature: _____



FORM 3: BANK GUARANTEE FOR CONTRACT PERFORMANCE SECURITY

[To be provided on the relevant legal document, as per applicable law, in the country of execution]

Bank Guarantee No.

Date.....

To

[Employer's Address]

Dear Sir/Madam,

In consideration of Employer's name (hereinafter referred to as Employer which expression shall unless repugnant to the context or meaning thereof include its successors, administrators, and assigns) having awarded to M/s with its Registered/Head Office at(hereinafter referred to as the 'Contractor' which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators, executors, and assigns), a Contract by the issue of Letter of Award No..... dated valued at[amount of foreign currency in words], [amount in figures], and [amount of local currency in words], [amount in figures], for (Insert Scope of Contract) and the Contractor has agreed to provide a Contract Performance Guarantee for the faithful performance of the entire Contract equivalent to ten percent (10%) of the said value of the Contract to Employer.

We (insert Name and Address of the bank issuing the Guarantee) having its Head Office at hereinafter referred to as the 'Bank' which expression shall, unless repugnant to the context or meaning thereof include its successors, administrators, executors and assigns), do hereby guarantee and undertake to pay Employer, on demand any and all monies payable by the Contractor to the extent of [insert amount of the Bank Guarantee and its currency] at any time up to@.....(day/month/year) without any demur, reservation, contest recourse or protest and or without any reference to the Contractor. Any such demand made by Employer on the Bank shall be conclusive and binding notwithstanding any difference between Employer and the Contractor or any dispute pending before any Court, Tribunal, or any other Authority. The Bank undertakes not to revoke this guarantee during its currency without the prior consent of the Employer.

An employer shall have the fullest liberty without affecting in any way the liability of the Bank under this guarantee from time to time to extend the time for performance of the Contract by the Contractor. Employer shall have the fullest liberty, without affecting this guarantee to postpone from time to time the exercise of any powers vested in Employer or of any right which they might have against the Contractor and to exercise the same at any time and any manner, and

either to enforce or to forbear to enforce any covenants, contained or implied in the Contract between Employer and the Contractor or any other course of remedy or security available to Employer. The Bank shall not be released of its obligations under these presents by any exercise by Employer of its liberty with reference to the matters aforesaid or any of them or by reason or any other acts of omission or commission on the part of Employer or any other indulgence shown by Employer or by any other matter or thing whatsoever which under the law would but for these provisions have the effect of relieving the Bank.

The Bank also agrees that Employer at its option shall be entitled to enforce this guarantee against the Bank as a Principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that Employer may have in relation to the Contractor's liabilities.

Notwithstanding anything contained herein above, our liability under this guarantee is restricted to and shall remain in force up to and including and shall be extended from time to time for such period, as may be desired by M/s on whose behalf this guarantee has been given.

All rights of Employer under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities after the above-mentioned date or from the extended date.

Dated thisday of20 at

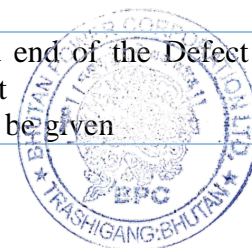
Witness:

..... (Signature) (Signature)
..... (Name) (Name)
..... (Official Address) (Official Address)

Authorized vide
Power of Attorney No.....

Date.....

Note:	(@) This date shall be ninety (90) days beyond the scheduled end of the Defect Liability Period of the last equipment covered under the Contract (#) Complete mailing address of the Head Office of the Bank to be given
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FORM 4: BANK GUARANTEE FOR ADVANCE PAYMENT

[To be provided on the relevant legal document, as per applicable law, in the country of execution]

Bank Guarantee No.

Date.....

To

[Employer's address]

Dear Sir/Madam,

In consideration of the Employer Corporation Ltd (hereinafter referred to as Employer) which expression shall unless repugnant to the context or meaning thereof include its successors, administrators, executors, and assigns having awarded to M/s..... with its registered/Head Office at (Here-in-after referred to as the Contractor) which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators, executors, and assigns, a Contract by issue of Employer's Notification of Award No. dated and the same having been unequivocally accepted by the Contractor resulting in a 'Contract', dated valued at*[amount of foreign currency in words], [amount in figures], and [amount of local currency in words], [amount in figures]* for *(insert Scope of Contract)* (Hereinafter called the Contract) and Employer has agreed to make an advance payment to the Contractor for performance of the above Contract amounting to*[insert currency and amount of the advance]*, as an advance against Bank Guarantee to be furnished by the Contractor.

We, *[Insert name and address of the bank issuing Branch]* having its Head Office at (Hereinafter referred to as the 'Bank' which expression shall, unless repugnant to the context of the meaning thereof, include its successors, administrators, executors, and assigns) do hereby guarantee and undertake to pay Employer immediately on demand any or all monies payable by the Contractor to the extent of *[insert currency and amount of the advance]*.....at any time up to@..... without any demur, reservation, contest, recourse or protest and/or without any reference to the Contractor. Any such demand made by Employer on the Bank shall be conclusive and binding notwithstanding any difference between Employer and the Contractor or any dispute pending before any Court, Tribunal, Arbitrator, or any other Authority.

An employer shall have the fullest liberty without affecting in any way the liability of the Bank under this guarantee from time to time to vary the advance or to extend the time for performance of the Contract by the Contractor. Employer shall have the fullest liberty, without affecting this guarantee to postpone from time to time the exercise of any powers vested in them or of any right which they might have against the Contractor and to exercise the same at any time in any

manner and either to enforce or to forbear to enforce any covenants contained or implied in the Contract between the Employer and the Contractor or any other course or remedy or security available to Employer. The Bank shall not be released of its obligations under these presents by any exercise by Employer of its liberty with reference to the matters aforesaid or any of them or by reason of any other act or forbearance or other acts of omission or commission on the part of Employer or any other indulgence shown by Employer or by any other matter or thing whatsoever which under law would, but for this provision, have the effect of relieving the Bank. The Bank also agrees that Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that Employer may have in relation to the Contractor's liabilities.

Notwithstanding anything contained hereinabove our liability under this guarantee is limited to..... *[insert currency and amount of the advance]*..... and it shall remain in force up to and including and shall be extended from time to time for such period as may be desired by M/s on whose behalf this guarantee has been given.

All rights of Employer under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities after the above-mentioned date or from the extended date.

Dated thisday of20 at

Witness:

..... (Signature) (Signature)
..... (Name) (Name)
..... (Official Address) (Official Address)

Attorney as per

Power of Attorney No:

Date.....

Note:	(@) This date shall be ninety (90) days beyond the scheduled date of Completion of the last Facility covered under the Contract.
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