REPUBLIC OF THE PHILIPPINES

NATIONAL POWER CORPORATION

(Pambansang Korporasyon sa Elektrisidad)

BID DOCUMENTS

Name of Project : **UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION**

Project Location : **NPC 69kV Roxas Substation, Roxas, Palawan**

Specs No. : **LuzP22Z1447Se**

Contents :

Design and Development Department

SECTION I

INVITATION TO BID

National Power Corporation
INVITATION TO BID
PUBLIC BIDDING – BCS 2022-0683

1. The NATIONAL POWER CORPORATION (NPC), through its approved Corporate Budget of CY 2022 intends to apply the sum of **(Please see schedule below)** being the Approved Budget for the Contract (ABC) to payments under the contract. Bids received in excess of the ABC shall be automatically rejected at Bid opening.

PR Nos./PB Ref No. & Description	Similar Contracts	Pre-bid Conference	Bid Submission / Opening	ABC/ Amt. of Bid Docs
HO-PIG22-019 / PB221109-JL00413 Design, Supply, Delivery, Installation, Testing and Commissioning of Batan Island Solar PV-Diesel Hybrid System (with ESS)	Design, Supply, Delivery, Installation, Test and Commissioning of Solar PV Plant/Hybrid PV-Diesel of at least 300kWp	28 October 2022 9:30 A.M	09 November 2022 9:30. A.M	₱ 48,493,800.00 / ₱ 25,000.00
HO-PIG22-024 / PB221109-JL00414 Upgrading of Existing Power Transformer from 5 MVA to 10 MVA and other Appurtenances in Roxas Substation • PCAB License: License Category of at least **"Category B – Electrical Work"** and registration classification of at least **"Medium A – Electrical Work"**	Supply, Delivery, Installation, Test and Commissioning or uprating/upgrading of at least 69kV Substation	28 October 2022 9:30 A.M	09 November 2022 9:30 A.M	₱ 49,708,000.00 / ₱ 25,000.00
Venue: Kañao Function Room, NPC Bldg. Diliman, Quezon City				

2. The NPC now invites bids for Items listed above. Delivery of the Goods is required **(see table below)** specified in the Technical Specifications. Bidders should have completed, within **(see table below)** from the date of submission and receipt of bids, a contract similar to the Project. The description of an eligible bidder is contained in the Bidding Documents, particularly, in Section II. (Instruction to Bidders).

PR No/s. / PB Ref No/s.	Delivery Period / Contract Duration	Relevant Period of SLCC reckoned from the date of submission & receipt of bids
HO-PIG22-019	Two Hundred Fifteen (215) Calendar Days	Ten (10) Years
HO-PIG22-024	Two Hundred Forty (240) Calendar Days	-

3. Bidding will be conducted through open competitive bidding procedures using a non-discretionary "*pass/fail*" criterion as specified in the 2016 revised Implementing Rules and Regulations (IRR) of Republic Act (RA) No. 9184.

   Bidding is restricted to Filipino citizens/sole proprietorships, partnerships, or organizations with at least sixty percent (60%) interest or outstanding capital stock belonging to citizens of the Philippines, and to citizens or organizations of a country the laws or regulations of which grant similar rights or privileges to Filipino citizens, pursuant to RA 5183.

4. Prospective Bidders may obtain further information from National Power Corporation, Bids and Contracts Services Division and inspect the Bidding Documents at the address given below during office hours (8:00AM to 5:00PM), Monday to Friday.

5. A complete set of Bidding Documents may be acquired by interested Bidders from the given address and website(s) and upon payment of the applicable fee for the Bidding Documents, pursuant to the latest Guidelines issued by the GPPB. *Bidding fee may be refunded in accordance with the guidelines based on the grounds provided under Section 41 of R.A. 9184 and its Revised IRR.*

6. The National Power Corporation will hold Pre-Bid Conference **(see table above)** and/or through video conferencing or webcasting which shall be open to prospective bidders.

   Only registered bidder/s shall be allowed to participate for the conduct of virtual pre-bid conference. **Unregistered bidders** may attend the Pre-Bid Conference at the Kañao Room, NPC subject to the following:

   a. Only a maximum of two (2) representatives from each bidder / company shall be allowed to participate during the virtual pre-bid conference.
   b. A "No Face mask / No Entry" policy shall be implemented in the NPC premises. Face mask shall be 3-ply surgical or KN95 mask type.
   c. The requirements herein stated including the medium of submission shall be subject to GPPB Resolution No. 09-2020 dated 07 May 2020
   d. The Guidelines on the Implementation of Early Procurement Activities (EPA) shall be subject to GPPB Circular No. 06-2019 dated 17 July 2019

7. Bids must be duly received by the BAC Secretariat through (i) manual submission at the office address indicated below; (ii) online or electronic submission before the specified time stated in the table above for opening of bids. Late bids shall not be accepted.

8. All Bids must be accompanied by a bid security in any of the acceptable forms and in the amount stated in **ITB** Clause 14.

9. Bid opening shall be on Kañao Function Room, NPC Head Office, Diliman, Quezon City and/or via online platform to be announced by NPC. Bids will be opened in the presence of the bidders' representatives who choose to attend the activity.

10. The National Power Corporation reserves the right to reject any and all bids, declare a failure of bidding, or not award the contract at any time prior to contract award in accordance with Sections 35.6 and 41 of the 2016 revised IRR of R.A. No. 9184, without thereby incurring any liability to the affected bidder or bidders.

11. For further information, please refer to:

Bids and Contracts Services Division,
Logistics Department

BIR Road cor. Quezon Avenue
Diliman, Quezon City
Tel Nos.: 8924-5211 and 8921-3541 local 5611/5211
Fax No.: 8922-1622
Email: bcsd@napocor.gov.ph / bcsd_napocor@yahoo.com

12. You may visit the following websites:

For downloading of Bidding Documents: https://www.napocor.gov.ph/bcsd/bids.php

RENE B. BARRUELA
Vice President, Corporate Affairs Group and
Chairman, Bids and Awards Committee

SECTION II

INSTRUCTION TO BIDDERS

SECTION II - INSTRUCTIONS TO BIDDERS

TABLE OF CONTENTS

SECTION II - INSTRUCTIONS TO BIDDERS

1. Scope of Bid

NPC invites Bids for the **UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION** , with Project Identification Number **LuzP22Z1447Se.**

The Procurement Project (referred to herein as "Project") is for the construction of Works, as described in Section VI (Specifications).

2. Funding Information

The GOP through the source of funding as indicated below for CY 2022 in the amount of **FORTY NINE MILLION SEVEN HUNDRED EIGHT THOUSAND PESOS (₱ 49,708,000.00).** The source of funding is the proposed Corporate Operating Budget of the National Power Corporation (NPC).

3. Bidding Requirements

The Bidding for the Project shall be governed by all the provisions of RA No. 9184 and its 2016 revised IRR, including its Generic Procurement Manual and associated policies, rules and regulations as the primary source thereof, while the herein clauses shall serve as the secondary source thereof.

Any amendments made to the IRR and other GPPB issuances shall be applicable only to the ongoing posting, advertisement, or invitation to bid by the BAC through the issuance of a supplemental or bid bulletin.

The Bidder, by the act of submitting its Bid, shall be deemed to have inspected the site, determined the general characteristics of the contracted Works and the conditions for this Project, such as the location and the nature of the work; (b) climatic conditions; (c) transportation facilities; (c) nature and condition of the terrain, geological conditions at the site communication facilities, requirements, location and availability of construction aggregates and other materials, labor, water, electric power and access roads; and (d) other factors that may affect the cost, duration and execution or implementation of the contract, project, or work and examine all instructions, forms, terms, and project requirements in the Bidding Documents.

4. Corrupt, Fraudulent, Collusive, Coercive, and Obstructive Practices

The Procuring Entity, as well as the Bidders and Contractors, shall observe the highest standard of ethics during the procurement and execution of the contract. They or through an agent shall not engage in corrupt, fraudulent, collusive, coercive, and obstructive practices defined under Annex "I" of the 2016 revised IRR of RA No. 9184 or other integrity violations in competing for the Project.

5. Eligible Bidders

5.1. Only Bids of Bidders found to be legally, technically, and financially capable will be evaluated.

5.2. The Bidder must have an experience of having completed a Single Largest Completed Contract (SLCC) that is similar to this Project, equivalent to at least fifty percent (50%) of the ABC adjusted, if necessary, by the Bidder to

current prices using the PSA's CPI, except under conditions provided for in Section 23.4.2.4 of the 2016 revised IRR of RA No. 9184.

A contract is considered to be "similar" to the contract to be bid if it has the major categories of work stated in the **BDS**.

5.3. For Foreign-funded Procurement, the Procuring Entity and the foreign government/foreign or international financing institution may agree on another track record requirement, as specified in the Bidding Document prepared for this purpose.

5.4. The Bidders shall comply with the eligibility criteria under Section 23.4.2 of the 2016 IRR of RA No. 9184.

6. Origin of Associated Goods

There is no restriction on the origin of Goods other than those prohibited by a decision of the UN Security Council taken under Chapter VII of the Charter of the UN.

7. Subcontracts

7.1. The Bidder may subcontract portions of the Project to the extent allowed by the Procuring Entity as stated herein, but in no case more than fifty percent (50%) of the Project.

7.1. The Bidder must submit together with its Bid the documentary requirements of the subcontractor(s) complying with the eligibility criterial stated in **ITB** Clause 5 in accordance with Section 23.4 of the 2016 revised IRR of RA No. 9184 pursuant to Section 23.1 thereof.

7.2. Subcontracting of any portion of the Project does not relieve the Contractor of any liability or obligation under the Contract. The Supplier will be responsible for the acts, defaults, and negligence of any subcontractor, its agents, servants, or workmen as fully as if these were the Contractor's own acts, defaults, or negligence, or those of its agents, servants, or workmen.

8. Pre-Bid Conference

The Procuring Entity will hold a pre-bid conference for this Project on the specified date and time and either at its physical address and/or through videoconferencing/webcasting} as indicated in paragraph 6 of the **IB**.

9. Clarification and Amendment of Bidding Documents

Prospective bidders may request for clarification on and/or interpretation of any part of the Bidding Documents. Such requests must be in writing and received by the Procuring Entity, either at its given address or through electronic mail indicated in the **IB**, at least ten (10) calendar days before the deadline set for the submission and receipt of Bids.

10. Documents Comprising the Bid: Eligibility and Technical Components

10.1. The first envelope shall contain the eligibility and technical documents of the Bid as specified in **Form NPCSF-INFR-01 - Checklist of Technical and Financial Documents, Section VIII - Bidding Forms.**

10.2. If the eligibility requirements or statements, the bids, and all other documents for submission to the BAC are in foreign language other than English, it must be accompanied by a translation in English, which shall be authenticated by the appropriate Philippine foreign service establishment, post, or the equivalent office having jurisdiction over the foreign bidder's affairs in the Philippines. For Contracting Parties to the Apostille Convention, only the translated documents shall be authenticated through an apostille pursuant to GPPB Resolution No. 13-2019 dated 23 May 2019. The English translation shall govern, for purposes of interpretation of the bid.

10.3. A valid PCAB License is required, and in case of joint ventures, a valid special PCAB License, and registration for the type and cost of the contract for this Project. Any additional type of Contractor license or permit shall be indicated in the **BDS**.

10.4. A List of Contractor's key personnel (e.g., Project Manager, Project Engineers, Materials Engineers, and Foremen) assigned to the contract to be bid, with their complete qualification and experience data shall be provided. These key personnel must meet the required minimum years of experience set in the **BDS**.

10.5. A List of Contractor's major equipment units, which are owned, leased, and/or under purchase agreements. supported by proof of ownership, certification of availability of equipment from the equipment lessor/vendor for the duration of the project, as the case may be, must meet the minimum requirements for the contract set in the **BDS**.

11. Documents Comprising the Bid: Financial Component

11.1. The second bid envelope shall contain the financial documents for the Bid as specified in **Form NPCSF-INFR-01 - Checklist of Technical and Financial Documents, Section VIII - Bidding Forms.**

11.2. Any bid exceeding the ABC indicated in paragraph 1 of the **IB** shall not be accepted.

11.3. For Foreign-funded procurement, a ceiling may be applied to bid prices provided the conditions are met under Section 31.2 of the 2016 revised IRR of RA No. 9184.

12. Alternative Bids

Bidders shall submit offers that comply with the requirements of the Bidding Documents, including the basic technical design as indicated in the drawings and specifications. Unless there is a value engineering clause in the **BDS**, alternative Bids shall not be accepted.

13. Bid Prices

All bid prices for the given scope of work in the Project as awarded shall be considered as fixed prices, and therefore not subject to price escalation during contract implementation, except under extraordinary circumstances as determined by the NEDA and approved by the GPPB pursuant to the revised Guidelines for Contract Price Escalation guidelines.

14. Bid and Payment Currencies

14.1. Bid prices may be quoted in the local currency or tradeable currency accepted by the BSP at the discretion of the Bidder. However, for purposes of bid evaluation, Bids denominated in foreign currencies shall be converted to Philippine currency based on the exchange rate as published in the BSP reference rate bulletin on the day of the bid opening.

14.2. Payment of the contract price shall be made in Philippine Pesos.

15. Bid Security

15.1. The Bidder shall submit a Bid Securing Declaration or any form of Bid Security in the amount indicated in the **BDS**, which shall be not less than the percentage of the ABC in accordance with the schedule in the **BDS**.

15.2. The Bid and bid security shall be valid until **One Hundred Twenty (120) calendar days** from the date of opening of bids. Any bid not accompanied by an acceptable bid security shall be rejected by the Procuring Entity as non-responsive.

16. Sealing and Marking of Bids

Each Bidder shall submit one copy of the first and second components of its Bid.

The Procuring Entity may request additional hard copies and/or electronic copies of the Bid. However, failure of the Bidders to comply with the said request shall not be a ground for disqualification.

If the Procuring Entity allows the submission of bids through online submission to the given website or any other electronic means, the Bidder shall submit an electronic copy of its Bid, which must be digitally signed. An electronic copy that cannot be opened or is corrupted shall be considered non-responsive and, thus, automatically disqualified.

17. Deadline for Submission of Bids

The Bidders shall submit on the specified date and time and either at its physical address or through online submission as indicated in paragraph 7 of the **IB**.

18. Opening and Preliminary Examination of Bids

18.1. The BAC shall open the Bids in public at the time, on the date, and at the place specified in paragraph 9 of the **IB**. The Bidders' representatives who are present shall sign a register evidencing their attendance. In case videoconferencing, webcasting or other similar technologies will be used, attendance of participants shall likewise be recorded by the BAC Secretariat.

In case the Bids cannot be opened as scheduled due to justifiable reasons, the rescheduling requirements under Section 29 of the 2016 revised IRR of RA No. 9184 shall prevail.

18.2. The preliminary examination of Bids shall be governed by Section 30 of the 2016 revised IRR of RA No. 9184.

19. Detailed Evaluation and Comparison of Bids

19.1. The Procuring Entity's BAC shall immediately conduct a detailed evaluation of all Bids rated "*passed*" using non-discretionary pass/fail criteria. The BAC shall consider the conditions in the evaluation of Bids under Section 32.2 of 2016 revised IRR of RA No. 9184.

19.2. If the Project allows partial bids, all Bids and combinations of Bids as indicated in the **BDS** shall be received by the same deadline and opened and evaluated simultaneously so as to determine the Bid or combination of Bids offering the lowest calculated cost to the Procuring Entity. Bid Security as required by **ITB** Clause 15 shall be submitted for each contract (lot) separately.

19.3. In all cases, the NFCC computation pursuant to Section 23.4.2.6 of the 2016 revised IRR of RA No. 9184 must be sufficient for the total of the ABCs for all the lots participated in by the prospective Bidder.

20. Post Qualification

Within a non-extendible period of five (5) calendar days from receipt by the Bidder of the notice from the BAC that it submitted the Lowest Calculated Bid, the Bidder shall submit its latest income and business tax returns filed and paid through the BIR Electronic Filing and Payment System (eFPS), and other appropriate licenses and permits required by law and stated in the **BDS**.

21. Signing of the Contract

The documents required in Section 37.2 of the 2016 revised IRR of RA No. 9184 shall form part of the Contract. Additional Contract documents are indicated in the **BDS**.

SECTION III

BID DATA SHEETS

SECTION III - BID DATA SHEET

ITB Clause	
5.2	For this purpose, contracts similar to the Project refer to supply, delivery, installation, test and commissioning or uprating/upgrading of at least 69KV Substation. The Single Largest Completed Contract (SLCC) as declared by the bidder shall be verified and validated to ascertain such completed contract. Hence, bidders must ensure access to sites of such projects/equipment to NPC representatives for verification and validation purposes during post-qualification process. It shall be a ground for disqualification, if verification and validation cannot be conducted for reasons attributable to the Bidder. Bidders must also comply with the Equipment and Manufacturer's Experience requirements specified under Section VI, Part II – Technical Data Sheets, B.2.0 : POWER TRANSFORMER, Clause B.2.18.3 (Equipment and Manufacturer's Experience).
7.1	Only a maximum of fifty percent (50%) of the Works may be subcontracted. All Subcontractors must be approved by NPC.
10.1	The list of on-going contracts (Form No. NPCSF-INFR-02) shall be supported by the following documents for each on-going contract to be submitted during Post-Qualification: 1. Contract/Purchase Order and/or Notice of Award 2. Certification coming from the project owner/client that the performance is satisfactory as of the bidding date. The bidder shall declare in this form all his on-going government and private contracts including contracts where the bidder (either as individual or as a Joint Venture) is a partner in a Joint Venture agreement other than his current joint venture where he is a partner. Non declaration will be a ground for disqualification of bid.
	The Statement of the bidder's Single Largest Completed Contract (SLCC) similar to the contract to be bid (Form No. NPCSF-INFR-03) shall be supported by the following documents to be submitted during Bid Opening: 1. Contract/Purchase Order 2. Owner's Certificate of Final Acceptance issued by the project owner other than the contractor or a final rating of at least Satisfactory in the Constructors Performance Evaluation System (CPES). In case of contracts with the private sector, an equivalent document (Ex. Official Receipt *or* Sales Invoice) shall be submitted.
10.3	The required License issued by the Philippine Contractors Accreditation Board (PCAB): License Category of at least **"CATEGORY B – ELECTRICAL WORK"** and registration classification of at least **"MEDIUM A – ELECTRICAL WORK".**

10.4	The list of key personnel shall include the following minimum requirements: **a. One (1) Project Manager** Professional Electrical Engineer (PEE) who had managed or supervised at least a similar project within the last ten (10) years. **b. One (1) Project/Site Engineer** Registered Electrical Engineer (REE) or Registered Civil Engineer who had supervised at least one (1) similar project within the last ten (10) years. Must have five (5) years professional experience on similar project. **c. One (1) Safety Officer 2** Construction Safety Officer who has completed at least forty (40) hours of Construction Safety and Health Training (COSH) from Occupational Safety and Health Center (OSHC) or Safety Training Organizations (STOs) accredited by the Department of Labor and Employment (DOLE) Valid Professional Regulations Commission (PRC) license for professional personnel, Construction Safety and Health Training Certificate from OSHC/STOs accredited by DOLE for the Safety Officer, shall be submitted and included as an attachment in the Standard Form NPCSF-INFR-09: List of Key Personnel Proposed to be Assign to the Contract. The above key personnel must either be employed by the Bidder or contracted by the Bidder to be employed for the contract to be bid.
10.5	The list of construction equipment (owned or leased) shall include the following minimum requirements: 1. Truck Mounted Crane (35 Tons Cap.) - 1 unit 2. Delivery/Transport Vehicle (Van or Pick-up) - 1 unit 3. Concrete Mixer, 1-bagger - 1 unit 4. Concrete Vibrator, Engine driven - 1 unit
10.6	Bidders shall also submit the following requirements in their first envelope, Eligibility and Technical Component of their bid: 1. Documents to be submitted with the Bid Proposal as specified in Annex A of Section VI – Part II, Technical Data Sheet (Electrical Works) 2. Complete eligibility documents of the proposed sub-contractor, if any
10.7	The prospective bidders shall declare its Joint Venture partner during the purchase of bid/tender documents. Any single bidder/s who already procured/secured the bidding documents but want to avail the Joint Venture Agreement (JVA) shall inform the BAC in writing prior to the bid opening for records and documentation purposes. Failure to do so shall be a ground for disqualification/non-acceptance of its bid.
12	No further instructions

15.1	The bid security shall be in the form of a Bid Securing Declaration or any of the following forms and amounts: 1. The amount of not less than *2% of ABC*, if bid security is in cash, cashier's/manager's check, bank draft/guarantee or irrevocable letter of credit; 2. The amount of not less than *5% of ABC* if bid security is in Surety Bond.
19.2	Partial Bid is not allowed
19.5	Bids shall also be further evaluated based on the computed Capitalized Cost of Transformer Losses. Its application and the formula are stated in the following clauses: 1. Section VI – Part I Technical Specification, Section EW 2.0 - Power Transformer, Clause EW - 2.3.2.8 (Transformer Loss Evaluation) 2. Section VI – Part II Technical Data Sheets, Annex A, Section A1.0 - Power Transformer, Clause A1.3 (Capitalized Cost for Transformer Losses) In the bid evaluation, the figures stated in the said Clauses shall be multiplied by its respective guaranteed loss value in kilowatts, and the resulting figures will be added to the bid price to give a total evaluated price for bid comparison. The corrected bid price (calculated bid) due to computational errors, omissions and discounts or its submitted bid price; PLUS: the computed Cost of Transformer Losses, shall become the total evaluated bid price, for bid comparison purposes. Based on the detailed evaluation of bids, those that comply with the above-mentioned requirements shall be ranked in the ascending order of their total evaluated bid prices, to identify the lowest evaluated bid price. It is understood however, that the award of contract shall be at the Bidder's submitted bid price or its calculated bid price due to computational errors, omissions and discount, whichever is lower, which shall be exclusive of computed cost of transformer losses.
20	a. Contract/Purchase Order and/or Notice of Award for the contracts stated in the List of all Ongoing Government & Private Contracts Including Contracts Awarded but not yet Started (NPCSF-INFR-02); b. Certification coming from the project owner/client that the performance is satisfactory as of the bidding date for all ongoing contracts stated in form NPCSF-INFR-02. c. Documents and Calculations to be submitted during post-qualification as specified in Annex B of Section VI – Part II, Technical Data Sheet (Electrical Works);

	Manufacturer's brochures, manuals and other supporting documents of equipment, materials, hardware and tools proposed by the bidders must comply with the technical specifications of such equipment, materials, hardware and tools. It shall be a ground for disqualification if the submitted brochures, manuals and other supporting documents are determined not complying with the specifications during technical evaluation and post-qualification process. Equipment, materials, hardware and tools proposed by the winning bidder to be supplied, which were evaluated to be complying with the technical specifications, shall not be replaced and must be the same items to be delivered/installed/used during the contract implementation. Any proposed changes/replacement of said items may be allowed on meritorious reasons subject to validation and prior approval by NPC. d. The licenses and permits relevant to the Project and the corresponding law requiring it as specified in the Technical Specifications, if any.
21	The following documents shall form part of the contract: 1. Notice to Proceed 2. Construction schedule and S-curve 3. Manpower Schedule 4. Construction Methods 5. Equipment Utilization Schedule 6. Construction safety and health program of the contractor duly approved by the Bureau of Working Condition (BWC) of the Department of Labor and Employment (DOLE) or proof of submission to BWC 7. PERT/CPM.

SECTION IV

GENERAL CONDITIONS OF CONTRACT

SECTION IV – GENERAL CONDITIONS OF CONTRACT

TABLE OF CONTENTS

SECTION IV – GENERAL CONDITIONS OF CONTRACT

1. Scope of Contract

This Contract shall include all such items, although not specifically mentioned, that can be reasonably inferred as being required for its completion as if such items were expressly mentioned herein. All the provisions of RA No. 9184 and its 2016 revised IRR, including the Generic Procurement Manual, and associated issuances, constitute the primary source for the terms and conditions of the Contract, and thus, applicable in contract implementation. Herein clauses shall serve as the secondary source for the terms and conditions of the Contract.

This is without prejudice to Sections 74.1 and 74.2 of the 2016 revised IRR of RA No. 9184 allowing the GPPB to amend the IRR, which shall be applied to all procurement activities, the advertisement, posting, or invitation of which were issued after the effectivity of the said amendment.

2. Sectional Completion of Works

If sectional completion is specified in the **Special Conditions of Contract (SCC)**, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date shall apply to any Section of the Works (other than references to the Completion Date and Intended Completion Date for the whole of the Works).

3. Possession of Site

3.1 The Procuring Entity shall give possession of all or parts of the Site to the Contractor based on the schedule of delivery indicated in the **SCC,** which corresponds to the execution of the Works. If the Contractor suffers delay or incurs cost from failure on the part of the Procuring Entity to give possession in accordance with the terms of this clause, the Procuring Entity's Representative shall give the Contractor a Contract Time Extension and certify such sum as fair to cover the cost incurred, which sum shall be paid by Procuring Entity.

3.2 If possession of a portion is not given by the above date, the Procuring Entity will be deemed to have delayed the start of the relevant activities. The resulting adjustments in contract time to address such delay may be addressed through contract extension provided under Annex "E" of the 2016 revised IRR of RA No. 9184.

4. The Contractor's Obligations

The Contractor shall employ the key personnel named in the Schedule of Key Personnel indicating their designation, in accordance with **ITB** Clause 10.3 and specified in the **BDS**, to carry out the supervision of the Works.

The Procuring Entity will approve any proposed replacement of key personnel only if their relevant qualifications and abilities are equal to or better than those of the personnel listed in the Schedule.

5. Performance Security

5.1. Within ten (10) calendar days from receipt of the Notice of Award from the Procuring Entity but in no case later than the signing of the contract by both parties, the successful Bidder shall furnish the performance security in any of the forms prescribed in Section 39 of the 2016 revised IRR.

5.2. The Contractor, by entering into the Contract with the Procuring Entity, acknowledges the right of the Procuring Entity to institute action pursuant to RA No. 3688 against any subcontractor be they an individual, firm, partnership, corporation, or association supplying the Contractor with labor, materials and/or equipment for the performance of this Contract.

6. Site Investigation Reports

The Contractor, in preparing the Bid, shall rely on any Site Investigation Reports referred to in the **SCC** supplemented by any information obtained by the Contractor.

7. Warranty

7.1. In case the Contractor fails to undertake the repair works under Section 62.2.2 of the 2016 revised IRR, the Procuring Entity shall forfeit its performance security, subject its property(ies) to attachment or garnishment proceedings, and perpetually disqualify it from participating in any public bidding. All payables of the GOP in his favor shall be offset to recover the costs.

7.2. The warranty against Structural Defects/Failures, except that occasioned-on force majeure, shall cover the period from the date of issuance of the Certificate of Final Acceptance by the Procuring Entity. Specific duration of the warranty is found in the **SCC**.

8. Liability of the Contractor

Subject to additional provisions, if any, set forth in the **SCC**, the Contractor's liability under this Contract shall be as provided by the laws of the Republic of the Philippines.

If the Contractor is a joint venture, all partners to the joint venture shall be jointly and severally liable to the Procuring Entity.

9. Termination for Other Causes

Contract termination shall be initiated in case it is determined *prima facie* by the Procuring Entity that the Contractor has engaged, before, or during the implementation of the contract, in unlawful deeds and behaviors relative to contract acquisition and implementation, such as, but not limited to corrupt, fraudulent, collusive, coercive, and obstructive practices as stated in **ITB** Clause 4.

10. Dayworks

Subject to the guidelines on Variation Order in Annex "E" of the 2016 revised IRR of RA No. 9184, and if applicable as indicated in the **SCC**, the Dayworks rates in the Contractor's Bid shall be used for small additional amounts of work only when the

Procuring Entity's Representative has given written instructions in advance for additional work to be paid for in that way.

11. Program of Work

11.1. The Contractor shall submit to the Procuring Entity's Representative for approval the said Program of Work showing the general methods, arrangements, order, and timing for all the activities in the Works. The submissions of the Program of Work are indicated in the **SCC.**

11.2. The Contractor shall submit to the Procuring Entity's Representative for approval an updated Program of Work at intervals no longer than the period stated in the **SCC.** If the Contractor does not submit an updated Program of Work within this period, the Procuring Entity's Representative may withhold the amount stated in the **SCC** from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Program of Work has been submitted.

12. Instructions, Inspections and Audits

The Contractor shall permit the GOP or the Procuring Entity to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors of the GOP or the Procuring Entity, as may be required.

13. Advance Payment

The Procuring Entity shall, upon a written request of the Contractor which shall be submitted as a Contract document, make an advance payment to the Contractor in an amount not exceeding fifteen percent (15%) of the total contract price, to be made in lump sum, or at the most two installments according to a schedule specified in the **SCC**, subject to the requirements in Annex "E" of the 2016 revised IRR of RA No. 9184.

14. Progress Payments

The Contractor may submit a request for payment for Work accomplished. Such requests for payment shall be verified and certified by the Procuring Entity's Representative/Project Engineer. Except as otherwise stipulated in the **SCC**, materials and equipment delivered on the site but not completely put in place shall not be included for payment.

15. Operating and Maintenance Manuals

15.1. If required, the Contractor will provide "as built" Drawings and/or operating and maintenance manuals as specified in the **SCC.**

15.2. If the Contractor does not provide the Drawings and/or manuals by the dates stated above, or they do not receive the Procuring Entity's Representative's approval, the Procuring Entity's Representative may withhold the amount stated in the **SCC** from payments due to the Contractor.

SECTION V

SPECIAL CONDITIONS OF CONTRACT

SECTION V – SPECIAL CONDITIONS OF CONTRACT

GCC Clause	
2	Sectional completion is not specified.
4	It shall also be the obligation and responsibility of the Contractor to carry out the Works properly and in accordance with this Contract, including but not limited to the following conditions: a. The Contractor shall conduct the Works with due regard to safety and health in accordance with its Construction Safety and Health Program (CSHP) duly approved by the Department of Labor & Employment (DOLE) and in compliance with the DOLE Department Order No. 13 – The Guidelines Governing Occupational Safety and Health in the Construction Industry. Failure to comply with the approved CSHP will be considered as non-compliance with the Contract and shall result to the imposition of Section 19, Violation and Penalties of the DOLE Department Order No. 13 and any appropriate sanctions such as, but not limited to: 1. Suspend the work until the Contractor complies with the approved CSHP with the condition that the work resumption will not incur additional cost to the Corporation; 2. Suspend payment of the portion of work under question; 3. Correct the situation by employing 3rd party and charge all expenses incurred to the Contractor's collectibles/securities; and 4. Report the condition to the Bureau of Working Conditions of the DOLE for their appropriate action. b. The Contractor shall be responsible for the strict compliance with the provision of the Philippine Laws affecting labor and operation of Work under the contract and shall be responsible for the payment of all indemnities arising out of any labor accident which may occur in the execution of the Works and for which he may be responsible under Republic Act 3428, as amended, known as the Workmen's Compensation Law. c. The Contractor is obliged to exercise due care so as not to endanger life and property in the vicinity of the Works where he operates in connection with this Contract. He shall be liable for all damages incurred in any manner by acts of negligence of his own, or his agents, employees, or workmen. d. It is the responsibility of the Contractor for the strict compliance with the requirements of the Philippine Clean Air Act of 1999 (R.A. 8749) and Philippine Clean Water Act of 2004 (R.A. 9275). The Contractor shall be liable for any damages/destructions to the environment including penalties that will be imposed by the Department of Environment and Natural Resources (DENR) arising from non-compliance of the requirements thereof.

	e. The Contractor shall be responsible for the strict compliance with the requirements of the Environmental Compliance Certificate (ECC) issued for this project (if any) and DENR Administrative Order No. 26. He shall be liable for any damages/destructions to the environment including penalties that will be imposed by the DENR arising from non-compliance thereof, in any manner by his acts or negligence, or by his agents, employees, or workmen in the execution of the Works. The Contractor may employ a Pollution Control Officer accredited with the DENR for the duration of the project, if so required by the DENR Administrative Order No. 26 f. It shall be the Contractor's responsibility for the correctness, accuracy and quality of works. NPC's approval does not relieve his contractual obligation and responsibility under this contract. g. Payment of all forms of taxes, such as value added tax (VAT) including municipal licenses and permits, and others that may be imposed by the Philippine Government or any of its agencies and political subdivisions in connection with the Contract shall be for the account of the Contractor. h. In general, the Contractor is totally responsible for the execution of the Works and therefore, takes upon himself all the technical, legal and economic risks and all obligations which could arise therefrom or connected therewith. The overall responsibility of the Contractor includes the responsibility for actions or omissions of his own personnel as well as the personnel of the sub-contractors.
4.1	NPC shall give access to the Site for the Contractor to commence and proceed with the works on the start date. The access to the site referred herein shall not be exclusive to the Contractor but only to enable him to execute the Work.
5	1. The following must be indicated in the performance bond to be posted by the Contractor: i. Company Name ii. Correct amount of the Bond iii. Contract/Purchase Order Reference Number iv. Purpose of the Bond: "To guarantee the faithful performance of the Principal's obligation to undertake *(Contract/Purchase Order Description)* in accordance with the terms and conditions of *(Contract No. & Schedule/Purchase Order No.)* entered into by the parties." 2. The bond shall remain valid and effective until the duration of the contract *(should be specific date reckoned from the contract effectivity)* plus sixty (60) days after NPC's acceptance of the last delivery/final acceptance of the project. 3. In case of surety bond, any extension of the contract duration or delivery period granted to the CONTRACTOR shall be considered as given, and any modification of the contract shall be considered as authorized, as if with the expressed consent of the surety, provided that such extension or modifications falls within the effective period of the said surety bond. However, in the event that the extension of

	the contract duration or delivery schedule would be beyond the effective period of the surety bond first posted, it shall be the sole obligation of the CONTRACTOR to post an acceptable Performance Security within ten (10) calendar days after the contract duration/delivery period extension has been granted by NPC. 4. Other required conditions in addition to the standard policy terms issued by the Bonding Company: i. The bond is a penal bond, callable on demand and the entire amount thereof shall be forfeited in favor of the Obligee upon default of the Principal without the need to prove or to show grounds or reasons for demand for the sum specified therein; ii. The amount claimed by the Obligee under this bond shall be paid in full and shall never be subject to any adjustment by the Surety; iii. In case of claim, the Surety shall pay such claim within sixty (60) days from receipt by the Surety of the Obligee's notice of claim/demand letter notwithstanding any objection thereto by the Principal.
6	No site investigation report.
7.2	In case of permanent structures, such as buildings of types 4 and 5 as classified under the National Building Code of the Philippines and other structures made of steel, iron, or concrete which comply with relevant structural codes (e.g., DPWH Standard Specifications), such as, but not limited to, steel/concrete bridges, flyovers, aircraft movement areas, ports, dams, tunnels, filtration and treatment plants, sewerage systems, power plants, transmission and communication towers, railway system, and other similar permanent structures: Fifteen (15) years. In case of semi-permanent structures, such as buildings of types 1, 2, and 3 as classified under the National Building Code of the Philippines, concrete/asphalt roads, concrete river control, drainage, irrigation lined canals, river landing, deep wells, rock causeway, pedestrian overpass, and other similar semi-permanent structures: Five (5) years. In case of other structures, such as Bailey and wooden bridges, shallow wells, spring developments, and other similar structures: Two (2) years.
8	Aside from the Liquidated Damages, the PROCURING ENTITY shall also impose a penalty in case the Contractor fails to meet the transformer guarantees. The penalty to be imposed to the Supplier shall be in accordance with Section VI - Part I, Technical Specifications (Electrical Works).
10	No dayworks are applicable to the contract.
11.1	The Contractor shall submit the Program of Work to the Procuring Entity's Representative within Ten (10) calendar days of delivery of the Notice of Award/Letter of Acceptance.
11.2	The period between Program of Work updates is Thirty (30) calendar days. The amount to be withheld for late submission of an updated Program of Work is One percent (1%) of contract amount.

12	During contract implementation, the Procuring Entity shall conduct Constructors Performance Evaluation in accordance with Section 12, Annex E of the Revised Implementing Rules and Regulation of R.A. 9184 using the NPC Constructors Performance Evaluation System (CPES) Guidelines. CPES ratings shall be used for the following purposes: a) eligibility screening/post-qualification; b) awarding of contracts; c) project monitoring & control; d) issuance of Certificate of Completion; and in adopting measures to further improve performance of contractors in the prosecution of government projects. Qualified Constructors Performance Evaluators (CPE) shall conduct project evaluation as follows: (a) During Construction - Except for those projects with a duration of 90 calendar days and below which may be subjected to at least one (1) visit, all projects shall be subjected to a minimum of two (2) evaluations to be performed by the CPE. The number of evaluations beyond the prescribed minimum shall be determined by the CPES-Implementing Unit based on the size, nature and complexity of the project and shall be subject to approval by the proper authorities within the agency. The first evaluation shall be performed when the project is at least thirty percent (30%) physically complete or as maybe required by the CPES-IU using the S-curve or other appropriate means to determine whether there is substantial work completed for evaluation. (b) Upon Completion - only one evaluation shall be performed by the CPE right after the Project Implementation Group reports one hundred percent (100%) completion of the project.
13	The maximum amount of advance payment is fifteen percent (15%) of the Contract Price and paid in lump sum.
14	No further instructions.
15.1	The date by which "as built" drawings and operating and maintenance manuals are required is within thirty (30) calendar days after completion of contract.
15.2	The amount to be withheld for failing to produce "as built" drawings and/or operating and maintenance manuals by the date required is Five percent (5%) of contract amount.

SECTION VI

TECHNICAL SPECIFICATIONS

PART I - TECHNICAL SPECIFICATIONS

GW - GENERAL WORKS

TABLE OF CONTENTS

GW - GENERAL WORKS

GW-1.0 PROJECT HIGHLIGHTS

GW-1.1 GENERAL

The works to be done under this specification shall generally consists but not limited to supply, delivery, installation, testing and commissioning of one (1) unit of Power Transformer complete with cooling control, monitoring, protection relay and other appurtenances for Roxas 69 kV Substation.

All equipment and materials which the Contractor shall supply and install shall be new and unused. They shall be suitable for their intended purpose complying with all applicable regulations, quality and dimension standards.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. The Contractor shall furnish high quality power transformers and its protections meeting the requirements of these specification and industry standards.

GW-1.2 LOCATION OF THE PROJECT

The contract to be bid is located at NPC 69 kV Roxas Substation, Sitio Umalad, Barangay 4, Roxas, Palawan.

GW-1.3 SCOPE OF WORKS

The scope of work shall cover but not limited to the following:

Civil Works/Architectural Works

1. Modification of the existing transformer foundation pad to accommodate the proposed new 10MVA power transformer; and

2. Establishment of temporary transformer pad for the relocated existing 5 MVA power transformer.

Electrical Works

1. Supply, delivery, installation, test and commissioning of one (1) unit of 10 MVA, 69/13.8 kV, 3-Ph, 60 Hz Two-Winding Transformer complete with all required accessories, appurtenances, spare and tools;

2. Temporary relocation of existing 5 MVA, 69/13.8/13.8kV, 3-Ph, 60 Hz Three-Winding Transformer including all associated accessories and other appurtenances;

3. Design, supply, erection and installation of temporary 69 kV receiving structure complete with steel pole, cross-arms, braces, bus conductor, line materials/hardware, grounding materials, line guards/covering and other accessories;

4. Design, supply, erection and installation of temporary 15 kV receiving structure complete with required pole, termination kits/lugs, grounding materials and other accessories;

5. Dismantling, re-terminate and test of existing Medium Voltage (15kV XLPE) Power Cables suitable/proper connection with the temporary relocated 5 MVA power transformer;

6. Supply, installation and test of new substation protection, monitoring and metering devices complete with auxiliary relays, instrument transformers, test blocks and other appurtenances required for the interfacing of supplied equipment;

7. Supply, installation and test of 125 Vdc battery bank complete with the required battery racks including spare parts/tools and accessories;

8. Supply, installation and test of new 125 Vdc battery charger complete with necessary devices and accessories including spare parts/tools and accessories;

9. Supply, installation and test of ground conductors, ground connectors, ground rods and other accessories required for the interfacing of the new 10 MVA Power Transformer grounding system to the existing grounding system;

10. Supply, installation and test of grounding materials for the relocated 5 MVA Power Transformer;

11. Supply, laying, tagging, bundling, termination and test of power, control and instrumentation cables for all equipment and devices of Roxas Substation;

12. Supply, installation and test of 69 kV Hard-drawn Aluminum (HAL) Bus Conductor complete with required associated line materials/hardware for the new 10 MVA Power Transformer;

13. Supply, laying, tagging, bundling, termination and test of power, control and instrumentation cables;

14. Supply and installation of embedded and/or exposed electrical metallic/non-metallic conduits, boxes, fittings and accessories for power and control cables;

15. Hauling, installation and test of existing power, control and instrumentation cables from NPC SPUG-LOD Minuyan Complex (San Jose Del Monte, Bulacan) to Roxas Substation (Roxas, Palawan);

16. Installation and test of Medium Voltage (15 kV XLPE) Power Cables to the new 10 MVA Power Transformer;

17. Dismantling and hauling of the relocated existing 5 MVA, 69/13.8/13.8kV, 3-Ph, 60 Hz Three-Winding Transformer including all

associated accessories and other appurtenances to the designated stockyard inside Roxas Substation Complex;

18. Dismantling, re-coiling and stocking of the existing 15kV XLPE Power Cables (temporarily connecting the secondary winding of the relocated 5 MVA power transformer and 13.8kV outdoor switchgear);

19. Dismantling of temporary 69 kV and 15 kV receiving structures including other accessories/appurtenances which are used for the temporary relocation of the 5 MVA power transformer;

20. Dismantling, re-coiling and stocking of the existing 15kV XLPE Power Cables (connecting the tertiary winding of the 5 MVA power transformer and 13.8kV outdoor switchgear);

21. Dismantling, re-coiling and stocking of the existing 69 kV aluminum bus conductor (connecting the 5 MVA power transformer to the disconnect switch);

22. Dismantling, crating and stocking of existing substation protection, monitoring and metering devices including auxiliary relays, instrument transformers, test blocks and other appurtenances;

23. Dismantling, crating and stocking of existing 125 Vdc battery bank including battery racks and other accessories;

24. Dismantling, crating and stocking of existing 125 Vdc battery charger including other devices and accessories;

25. Dismantling, re-coiling and stocking of existing instrumentation and control cables of all equipment and devices of Roxas Substation; and

26. All other works and services including those not specifically detailed herein but are required to fully complete the project.

GW-1.4 CONTRACT PERIOD

The Contractor shall complete the works within **TWO HUNDRED FORTY (240) CALENDAR DAYS**. The contract period is inclusive of twenty (20) rainy/unworkable days considered unfavorable for the prosecution of work at the site. The number of calendar days shall be counted from the date of contract effectivity as specified in the Notice to Proceed.

GW-2.0 GENERAL ADMINISTRATIVE REQUIREMENTS

GW-2.1 GENERAL

GW-2.1.1 Purpose

This Section specifies the general requirements applicable to engineering documentation, planning and scheduling, inspection, tests, materials, workmanship and standards related to the implementation of the Contract.

Supplementary requirements of a special nature are contained in subsequent sections.

GW-2.1.2 Correspondence

To expedite action or response to all communications pertaining to this Contract, the Contractor shall address all such communication to:

THE MANAGER
Design and Development Department
National Power Corporation
Quezon Avenue corner Agham Road
Diliman, Quezon City

with a copy furnished to the Vice President, Power Engineering Services.

The Contractor shall maintain a register for all correspondences which shall be accessible to the NPC for information. The Contractor shall forward correspondences to the NPC in one (1) original.

All correspondences between the NPC and the Contractor shall be numbered consecutively.

GW-2.1.3 Language and System of Measurement

All documentation relative to this Contract shall be in English. Submitted drawings, literature, etc., which are not in English language will be considered as not submitted at all.

Metric units shall be used in all documents, correspondence, technical schedules and drawings. On drawings or printed pamphlets where other units have been used, the metric equivalent shall be marked in addition.

GW-2.2 CONTRACTOR'S ORGANIZATION AND PERSONNEL

GW-2.2.1 Organization

The Contractor shall maintain in its project site offices, the Contractor's project organization charts for management, control and execution of the Contract. The Contractor's organization and personnel shall be as stated in the proposal.

The Contractor shall maintain an up-to-date project organization chart, which shall be submitted to the NPC for approval in the event of any changes.

GW-2.2.2 Key Positions

The key positions in the organization charts of the Contractor pertain to individuals assigned to management/supervisory positions, who at any time during the execution of the work can give decision and recommendation to the NPC on matters pertaining to the proper and early completion of the Work.

The appointment, transfer and replacement of personnel to all key positions shall be subject to the NPC's prior approval.

Engineering and procurement in key positions shall be committed to continue through the Contract period in order to maintain continuity.

GW-2.3 PLANNING AND SCHEDULING

GW-2.3.1 General

The Contractor shall be responsible for planning and scheduling, progress monitoring and reporting of all works and activities at sites.

The Contractor shall submit for approval by the NPC within thirty (30) days of the Effective Date of Contract, a detailed Contract Schedule resulting from the deployment of the Contractor's project management tool(s) for monitoring project activity progress, such as a Critical Path Method (CPM) Network or Project Evaluation and Review Technique (PERT) Diagram. The detailed schedule shall show commencement and completion dates for at least the following activities and "milestones":

a. Engineering Design;
b. Submittal of specifications and drawings for review and approval of NPC;
c. Fabrication or manufacture
d. System integration and shop testing;
e. Factory Acceptance Tests;
f. Shipments;
g. Civil works, erection;
h. Installation, testing and commissioning;
i. Trial operation;
j. Handover to the NPC.

GW-2.3.2 Format and Presentation

The Contractor shall prepare an activity network with the activities listed in early start order and showing the following:

a. activity code
b. activity description
c. duration in days
d. early start and finish dates
e. late start and finish dates.

The Contractor shall also prepare a bar chart identifying all activities which cannot be performed without the NPC's approval, and the need dates for the NPC's decision.

The Contract Schedule submitted shall meet the completion dates in the Construction Schedule and Schedule of Timings and shall clearly demonstrate the manner in which the various phases of the Works shall be completed.

All activities required for execution of the Works shall be carried out in accordance with the sequence and times and completion dates shown on the Contract Schedule or subsequent revisions thereto as approved by the NPC.

GW-2.3.3 Progress Monitoring Principle and System

Throughout the duration of the Contract, the Contractor shall monitor progress of the Works, and shall immediately advise the NPC in advance of any anticipated schedule delays, and the reason therefore.

If the Contractor believes it is necessary or advantageous to change the sequence of events shown on the Contract Schedule, he shall submit a proposed revision accompanied by a full explanation of the reasons and ramification of the change to the NPC for approval. No change shall be made in the order in which the Works activities are being performed until the NPC's approval for the revised Contract Schedule has been obtained.

Actual progress of each activity of the Works shall be compared with progress indicated on the approved Contract Schedule at least once every month by the Contractor.

After the NPC approves the Contractor's detailed Contract Schedule and planned activity completion dates, the Contractor shall update and analyze the Contract Schedule once a month and submit updated revision to the NPC on or before the 5th day of the following month.

The Contractor shall not change the sequence of activities shown on the approved Contract Schedule without the NPC's prior approval.

GW-2.4 MEETINGS

GW-2.4.1 Progress Review Meetings

The NPC shall schedule and hold monthly progress review meetings with the Contractor to a mutually agreed agenda. The meetings shall normally take place at the Contractor's site offices.

GW-2.4.2 Interface Meetings

The Contractor shall attend interface meetings with the NPC's other contractors as arranged by the NPC on a monthly or specifically called basis. The Contractor may also call for such meetings, if necessary.

GW-2.4.3 Design Review Meetings

The Contractor may request for a design review meeting during the processing stage of seeking the approval of the NPC to all design drawings to review, clarify and evaluate the design submitted with reference to the tender, the final design and the Contract Specification. The Contractor shall submit a meeting agenda seven (7) days prior to the meeting.

GW-2.4.4 Other Meetings

The Contractor shall arrange discipline meetings and other meetings as necessary with sub-contractors, etc. The NPC shall be notified in due time of such arrangements and given opportunity to attend.

The Contractor and the NPC shall, as required, hold meetings on specific subjects.

GW-2.4.5 Call for Meetings

Except for regular scheduled meetings, calls for meetings and agenda shall be sent out by the party calling the meeting to all requested attendees.

GW-2.4.6 Minutes of Meetings

Minutes shall be prepared by the Contractor on an agreed form and be issued for the NPC's review the next working day after the meeting has taken place. Minutes shall be approved by the NPC before copies are distributed to all attendees.

Matters requiring action shall be assigned the responsible party with dates for completion of such action. Result of action from previous meetings shall be recorded.

Copies of minutes of meetings from interface meetings shall be sent to the NPC in six (6) copies.

GW-2.5 REPORTS

GW-2.5.1 Monthly Reports

The Contractor shall from the second month after Commencement Date, submit to the NPC a monthly report related to the Works performed during the previous month. The Contractor shall present the report with diagrams in printed format.

Cut-off date for the report shall be the last Sunday of each month. The monthly report shall be submitted to the NPC no later than 12.00 hours on Wednesday after the cut-off date. The monthly report shall include as a minimum the following items:

a. narrative of major achievements and any deviations from time schedule, reasons for delays and deviations, with recommended actions and potential effects;
b. the Contract Detail Schedule showing the status at the cut-off date by means of a front line or equivalent;
c. a systematic listing and analysis of all significant time critical activities;
d. a summary of HSE activities and reported incidents in own and major sub-contractor's activities;
e. report on interface activities; and
f. narrative report on quality management activities.

GW-2.5.2 Close-out Reports

Project Control Close-out Report

The Contractor shall submit to the NPC a project control close-out report within ten (10) days after issue of the Completion Certificate which shall contain as a minimum the following items:

a. final as-is Contract Detail Schedule;
b. final as-is cost report; and
c. final as-is Contract amendment (if any) and Variation Order register, if any.

GW-2.6 HEALTH, SAFETY AND ENVIRONMENT (HSE)

GW-2.6.1 General

The Contractor shall at all times during the performance of the Contract be responsible for the safety of all personnel involved therewith.

Safe working practice for engineering and manufacturing shall be based on regulations, standards and HSE objectives.

The Contractor shall take all necessary precautions in connection with the performance of the Works in order to ensure the safety and health of the personnel of the NPC, the Contractor as well as Third Parties, and to protect the Works, the property of the NPC and all Third Parties.

The Contractor shall prepare and HSE program and submit this to the NPC for review and acceptance within thirty (30) days after the Effective Date of Contract.

The HSE program shall indicate how the Contractor shall implement his HSE requirements, how to perform follow-up and a proposed level of reporting to the NPC. The Contractor has the overall responsibility to ensure that all Site activities are planned, organized, performed and documented according to the Contractor's program. Accordingly, the Contractor is responsible for coordinating the HSE activities for all Site personnel working on the Contract.

GW-2.6.2 Reporting to the NPC

All situations not complying with approved procedures and other requirements shall immediately be reported to the NPC. All accidents shall be reported to the NPC.

GW-2.6.3 Pollution Control

The Contractor shall perform the Works without discharge into the atmosphere, from any source whatever, smoke, dust or other air contaminants in violation of law.

GW-2.6.4 Fossils and Articles of Value

All fossils, coins, precious or semi-precious stones, precious metals, articles of value or antiquity, and structures and other remains or things of geological or archaeological interest discovered on the Site of the Works shall be deemed to be the absolute property of the Government. The Contractor shall take appropriate precautions to prevent his workmen or any person from removing or damaging any such article or thing and shall immediately, upon discovery and carry out, at the expense of the Government, the NPC's orders as to the disposal of same.

GW-2.7 DOCUMENTS TO BE PREPARED BY THE CONTRACTOR

GW-2.7.1 General

The general documents, calculations, certifications, manuals, drawings, etc. relating to the manufacturing works, civil works, installation, testing and commissioning works which are to be prepared during detailed design by the Contractor are listed here below. The Contractor's attention is drawn to various sections of this Specification, where detailed contents of documentation are specified.

GW-2.7.2 Outline Drawings

The Contractor shall, within sixty (60) calendar days after the Effective Date of Contract, submit outline drawings of the equipment to be furnished under this Contract, together with weights, external forces, anchoring details and sufficient overall dimensions to facilitate preparation of final designs of the structure foundations.

GW-2.7.3 Diagrams

Schematic, circuit and wiring diagrams including list of materials, cable lists, etc. shall also be submitted by the Contractor for approval.

These diagrams shall show the internal and external connections of all apparatus, their designation, terminal numbers, color codes, etc. and shall be used for manufacturing, equipment installation and operation of the equipment.

GW-2.7.4 Detailed Drawings, Designs and Specifications

Before proceeding with the manufacture of equipment, the Contractor shall submit corresponding detailed drawings, designs and detailed specifications (in typewritten hardbound form) which shall show all details of materials, manufacture, assembly, testing, erection, commissioning, operation and maintenance of the equipment in conformity with the Contract requirements.

The detailed drawings and specification shall include, but not necessarily be limited to the following:

a. general assembly drawings;

b. assembly drawings, showing:

1. sectional views
2. details of mounting of the internal equipment,
3. function of the assemblies,
4. adjustment and operating ranges,
5. concrete pedestals and foundation bolts and anchors'
6. field tolerances,
7. all field joints,
8. methods of lubrication (if required)

c. detail manufacturing drawings showing:

1. detail dimensions
2. tolerances
3. materials
4. nameplate diagrams

d. engineering instructions and detailed specifications for:

1. manufacturing
2. fabrication
3. painting, including final color scheme
4. heat treatment
5. welding
6. surface treatment
7. testing

GW-2.7.5 Design Computation and Final Design Data

After the Contractor has completed the preliminary design of the equipment, he shall submit the final design data, design analysis and design computations (referred to as designs) along with all other specified designs and studies, all in typewritten and book-bound form, clearly laid out with all the design criteria and standards indicated for the NPC's review and approval.

GW-2.7.6 Parts Bills

The Contractor shall submit with the first drawing issue, where applicable, corresponding parts bills. Reference to the respective detail or assembly drawing, materials used or catalog shall be made.

GW-2.7.7 Catalogue Cuts, Illustrations, Etc.

Applicable requirements of this paragraph with reference to drawings shall apply equally to catalogue cuts, illustrations, printed specifications, design data, analysis and calculation, and manufacturer's descriptive literature and instructions for all equipment furnished to demonstrate fully that all parts will conform with the requirements and intent of the Contract Documents.

GW-2.7.8 Installation Manual

The Contractor shall provide the NPC with an Installation Manual covering installation procedure and instruction to facilitate smooth erection, assembly and testing on site of all equipment to be installed.

The instructions therein shall specify the exact procedures to be followed during installation, indicate data to be measured and recorded (adjustments, setting of limits, etc.), quantities, dimensions and tolerances to be checked, etc.

The manual shall include information on handling and slinging the major pieces of equipment, erection, tolerances, settings and adjustments and special precautions to be taken during installation.

The Contractor shall submit six (6) copies each of the Installation Manual for each equipment per substation per schedule to the NPC.

GW-2.7.9 Commissioning Manual

The Contractor shall provide the NPC with a Commissioning Manual, which shall be similar in size and form to the Installation Manual and shall include procedures and instructions to be followed during the commissioning of all equipment to be installed.

The instructions therein shall specify the exact procedures to be followed during commissioning and shall indicate all data to be measured (and where appropriate, recorded in the manual itself) and all adjustments, setting of limits, etc., quantities, dimensions and tolerances to be checked.

The Contractor shall submit six (6) copies each of the Commissioning Manual for each equipment per substation per schedule to the NPC

GW-2.7.10 Operation and Maintenance Manual

The Contractor shall provide the NPC with an Operation and Maintenance Manual similar in size and form with the other manuals and shall include procedures and instructions to be followed by the operating and maintenance staff necessary for reliable operation and maintenance of the equipment.

The manual shall contain at least the following documents and data as a minimum:

- General description of the equipment, operation in particular;
- Main technical characteristics;
- Connection to external system;
- Instructions for operating personnel including periodic tests, check-points, actions required following each individual alarm signal, etc.;
- Summary of important rules, standards, safety precautions and instructions to be followed during equipment operation and maintenance;
- Safety and warning signs to be placed in the plant/substations, etc.;
- Enclosures: Important principle diagrams.

Sections on "maintenance" shall be divided into two parts, namely:

a. Current (preventive) maintenance indicating inspection periods, routine cleaning and lubricating procedures (if required), safety checks, adjustments, etc.;

b. Repairs and overhauls describing the dismantling, removal and replacement of parts (with spare parts), trouble-shooting guides, repair instructions, etc.

The Operation and Maintenance Manual supplemented by any additional drawings and project documents to be submitted to the NPC will be the only document to be generally used by the power plant/substation operating staff.

The Contractor shall submit six (6) copies each of the Operation and Maintenance Manual for each equipment per substation per schedule to the NPC. Likewise, four (4) sets of CDs containing these documents preferably in MS WORD Format shall be provided. Other format can be accepted provided software for this format is included in the CDs that will be furnished.

GW-2.7.11 Final/As-Built Drawings

The Contractor shall furnish a complete set of an original reproducible copies of an approved type and four (4) sets of recordable DVDs which can be loaded and handled on a personal computer each containing copies of all drawings as finally approved and built. Such DVDs shall be suitable for DVD ROM/WRITE drive of computer system. The Contractor, if required in the Technical Data Sheets, shall supply the necessary hardware and software as a complement for the submission of Final/As-Built Drawings. Four (4) additional prints of same drawing with dark lines on a white background shall be furnished. For all approved drawings with no subsequent revisions, the reproducible copies earlier furnished may be considered part of this set. The NPC will not release the final payment and the performance security until the foregoing conditions have been fulfilled.

GW-2.8 PRESENTATION OF DOCUMENTATION

All documents to be prepared by the Contractor shall be submitted to the NPC for approval. The timing of such submission shall be in accordance with Section GW-2.9, Procedure for Delivery of Documents.

All documents to be approved by the NPC shall meet the following requirements:

a. Metric units shall be used in all documents, correspondence, technical schedules and drawings.

b. Drawings, electrical diagrams, key charts, process diagrams, etc., shall be in A3 format and flow directions shall be from left to right or from top to bottom. The NPC's document number, document name and revision index must be readable when folded to A4. It is of vital importance that cross references between electrical diagrams are performed in a way

that makes it possible to follow any signal from its source to its visualized position.

c. All other documentation shall be forwarded in A4 format with four (4) holes at intervals of 80-80-80 mm symmetrically around the center axis of the document. The NPC's document number, document name and revision index must be readable on all pages.

d. All drawings and copies shall be on white paper and with black print unless otherwise agreed upon.

e. All drawings shall be provided with clear space (approximately 80 mm x 50mm) for the NPC's stamping of **"Approved"** or **"Approved with Corrections Indicated"** or **"Returned for Correction".**

"Approved"; this mark authorizes the Contractor to proceed with the Contract Work therein indicated.

"Approved with Corrections Indicated"; this mark authorizes the Contractor to proceed with the Contract Work therein indicated taking into account of the notes and/or comments by the Contractor and re-submit the drawings, specifications or designs for approval.

"Returned for Correction"; this mark requires the Contractor to make the corrections indicated and re-submit the drawings, specifications or designs for approval before commencing the Contract Work therein indicated.

f. For documentation submitted in binders, the binders shall have four (4) rings at intervals of 80-80-80mm symmetrically around the center axis. The maximum width of the binder shall be 75 mm. The binders shall have text at front and at spine.

Award of contract does not imply approval of drawings and data submitted by the Contractor with his tender.

Approval of the Contractor's drawings shall not be held to relieve the Contractor or any part of the Contractor's obligations to meet all the requirements of this specification nor of the responsibility for the correctness of the Contractor's drawings.

When revised drawings or drawings which have been returned to the Contractor marked **"Approved with Corrections Indicated"** or **"Returned for Correction"** are re-submitted for approval, the revision block shall be completed with the description and date of revision and the appropriate revision letter or numeral which shall be clearly indicated adjacent to the revision or modification which requires approval.

No revision affecting the design shall be made after a drawing has been **"Approved"** without re-submitting the drawings suitably revised for formal approval.

The NPC will complete the review and/or approval of the Contractor's drawings within twenty (20) calendar days after receipt at NPC office. If within the twenty (20) calendar days, Contractor has not received any reply from the NPC regarding the approval drawings, the Contractor may proceed with the design and manufacture of equipment or materials as if the drawings have been approved. The Contractor however, shall not be held to be relieved to meet all the requirements of this specification nor of the responsibility for the correctness of the Contractor's drawings.

GW-2.9 PROCEDURE FOR DELIVERY OF DOCUMENTS

GW-2.9.1 General

The Contractor shall submit the following information to the NPC. The number of copies to be supplied shall be as indicated below:

GW-2.9.2 Within Thirty (30) Days after the Effective Date of Contract:

Detailed time schedule showing the commencement and completion dates for the various activities and milestone specified in Section GW-1.3

six (6) sets of:

- Drawing classification plan
- List of detailed drawings
- Quality Control and Assurance Program
- Detailed Contract Schedule

GW-2.9.3 Within Forty-Five (45) Days after the Effective Date of Contract:

six (6) sets of:

- Design and manufacturing schedules
- Delivery, erection and commissioning schedules
- Principal drawings, schemes, tables and electrical diagrams
- Type test reports and literature concerning the equipment if not submitted with the bid
- A program of performance, material and workshop tests to be carried out

GW-2.9.4 Within Sixty (60) Days after the Effective Date of Contract:

six (6) sets of:

- Outline drawings of the equipment
- Loading of foundations for all items of equipment to be supplied and details of anchors and supports
- Principal electrical diagrams
- Schematic diagrams
- Drawings for structures
- Delivery of all drawings related to civil works

GW-2.9.5 Before Beginning of Manufacturing

six (6) sets of:

- Detailed manufacturing drawings with all important dimensions, final assembly drawings, governing and control schemes, cabling and wiring diagrams and block and circuit diagrams intended to aid understanding and provide full information about the principles of operation
- Performance and stress calculations as the NPC may require

GW-2.9.6 During Manufacture

six (6) sets of:

- Progress photographs of the shop work done. Photographs shall be approximately 20 x 25 cm in size, including a margin of 2.5 cm on one of the 25 cm sides for binding. Four (4) views will be required for each piece of equipment. Each photograph shall contain upon its face the date, the name of the manufacturer and the title of the view taken.
- Notice of material tests and shop inspection

GW-2.9.7 At Least Fifteen (15) Days Prior to Shipment

- Six (6) copies of Inspection report
- Five (5) copies of Test certificates or test reports together with certificate of inspections (additional two (2) complete set bound in books required).

GW-2.9.8 At Least Thirty (30) Days Prior to Shipment

- Six (6) sets of packing lists for each consignment
- Six (6) sets of instructions for loading, unloading, handling and special precautions to be observed for storage at site
- Six (6) sets of Installation Manuals for each equipment to be supplied

GW-2.9.9 Within Ten (10) Days After the Last Shipment of Equipment

- Six (6) sets of Commissioning Manual
- Six (6) sets of Operating and Maintenance Manual

GW-2.9.10 Before Issuance of Certificate of Provisional Acceptance

- One (1) reproducible (rolled) and six (6) light copies of all drawings marked "**Final/As-Built Drawings**" and four (4) sets of recordable CDs each containing copies of all the drawings as finally approved and built.

GW-2.10 QUALITY ASSURANCE REQUIREMENTS

GW-2.10.1 General

The Contractor shall have a well-organized Quality Assurance Program (QAP) which shall comply with the requirements of ISO 9001 – "Model for Quality Assurance in Design/Development, Production, Installation and Servicing", or equivalent quality standard relevant for the Works to assure that

items and services, including subcontracted items and services, comply with this specification.

Within thirty (30) days of the Effective Date of Contract, the Contractor shall submit six (6) copies of his complete quality control and assurance procedures, manuals for review and approval by the NPC. The manual shall include pro-forma check lists for all requirements of the Contractor's quality control and assurance program and those called for in this Specification.

GW-2.10.2 Quality Assurance Program

The Contractor shall, for all work covered by the Contract:

a. Establish procedures for adequate planning and resourcing of all quality related activities including the preparation of quality plans.

b. Establish measures for the identification and control of items throughout all stages of the Contract. This shall include measures to maintain traceability as identified in agreed quality plans.

c. Arrange for the protection of the quality of the product to include delivery to the specified destination.

d. Control their measuring and test equipment in accordance with established procedures for measurements and calibration systems and ensure that such equipment that may be used by subcontractors to verify work is similarly controlled.

e. Ensure adequate quality systems exist for compliance with the requirements identified in Sections GW-2.10.1 to GW-2.10.10 inclusive.

Where any site installation and/or test and commissioning work is involved, the Contractor shall prepare contract-specific quality assurance procedures in agreement with the NPC prior to commencements of such works.

The Contractor shall be responsible for specifying the quality assurance requirements to his subcontractors, for approving subcontractor's quality assurance program and for ensuring compliance with the requirements.

The Contractor shall ensure that all appropriate technical information is extracted from the Contract documents and specifications and passed on to the subcontractors.

The Contractor shall ensure that all computer systems and software to be utilized on the project is qualified for the application under consideration and such qualification is documented.

GW-2.10.3 Quality Plan

The Contractor shall establish and implement quality plans detailing the specific activities, design reviews, operations, control procedures, inspections, testing, approvals and certification requirements applicable. All procedures, which support the quality plan shall be referenced and distributed

to the NPC together with the quality plan. Quality plans shall be submitted to the NPC for review and approval.

Where inspection schedules are generated in support of a quality plan, these are also required by the NPC for review and approval. The format and content of schedules shall ensure that inspection operations are planned and performed in a systematic manner.

The Contractor shall keep the NPC informed of any changes in the quality plan during the Contract period.

The quality plan shall document how the Contractor shall apply his quality system in the execution of the Contract. For the quality plan description and definition, the Contractor is referred to ISO 8402 and ISO 9000-4. The quality plan shall meet the guidelines of ISO 10005.

The quality plan shall consist of a set of plans, for which other terms than quality plan may be used, e.g. inspection plan. The hierarchy of the quality plan shall be shown. The quality plan shall contain a master test plan.

The Interface Coordination plan shall be a part of the Quality Plan and reflect the interfaces in the project and to the Scope of Work of the Contract. The Interface Coordination plan shall be a tool in safeguarding the handling of interface issues as well as a documentation of the same. The plan shall be maintained on a continuous basis and shall contain all interfaces towards other contractors and/or the NPC, including target dates for exchange of information/documentation. The Contractor shall prepare the required documentation as input to other contractors in order to enable them to perform their scope of works.

Documents referred to in quality plans shall be available to the NPC for review, if required.

Specific quality plans shall be prepared for site work and submitted for review and approval by the NPC prior to commencement of such work.

The Contractor shall approve all quality plans, inspection and test schedules of their subcontractors and vendors.

The Contractor shall identify his verification requirements on the quality plans submitted to the NPC for review and approval and shall identify the following:

a. Stages subject to random surveillance.

b. Inspection that require to be carried out or witnessed, by the NPC or a third party following satisfactory verification and acceptance by the Contractor.

c. Hold points beyond which work cannot proceed before completion of all operations, verifications and related activities identified after the previous hold point on the quality plan.

GW-2.10.4 Subcontractors and Suppliers

For each subcontractor, the Contractor shall identify the relevant quality standard ISO 9001, 9002 or 9003 to be selected in accordance with guidelines given in ISO 9000-1 and ISO 9000-3. The Contractor shall asses the subcontractor's quality system and their implementation to confirm adequate qualification standard.

The Contractor shall plan and carry out the Quality Surveillance (QS) of his subcontractors (ref. ISO 8402, Clause 3.11) at a level of detail sufficient to ensure fulfillment of the quality requirements of the Contract. The NPC shall have the right to participate as observer in such QS activities.

The Contractor shall submit his QS plans to the NPC for acceptance and keep the NPC informed of any change thereof.

GW-2.10.5 Quality Audits

The Contractor shall plan and carry out quality audits in his own organization and in subcontractors' organizations. The NPC shall review the Contractor's audit plans and coordinate his own audit plans with the Contractor's. The scope and frequency of the audits shall be adequate to confirm that the quality activities and results comply with the quality system and the planned arrangements.

NPC reserves the right to request, review and maintain for the duration of the contract a copy of the Contractor's Quality Manual.

During the course of the Contract, NPC reserves the right to carry out quality audits of the Contractor, subcontractors or their subcontractors. Monitoring will be by means of surveillance of activities at the work locations and where appropriate by formal audits. Representatives of the NPC shall be afforded unrestricted access, facilities and assistance at all reasonable times to carry out this quality audits.

GW-2.10.6 Records

The Contractor shall generate records as required by the quality assurance system and quality plans. Records, including audit reports shall be made available for inspection by NPC.

All records shall be concisely compiled, indexed and cross referenced to the project contract number and the relevant subcontract numbers. They shall be clearly identifiable to the individual parts and assemblies to which they refer. Those records required by the NPC, as defined in the contract specifications and quality plans shall be available at the time of delivery of the equipment. Such records shall include reports and certification in respect of pressure retaining components together with general traceability records for all items through certification and build documentation as a minimum. Six (6) copies of these records shall be supplied to NPC with the exception of radiographic films where the original set of films shall be supplied.

All records generated during the course of the Contract, including those generated as evidence of effective implementation of the quality assurance program of the Contractor and his subcontractors, shall be retained by the Contractor for a minimum period of five (5) years from the date of contract completion. These records shall be made available to NPC on request during the retention period.

GW-2.10.7 Particular QA Requirements

General

As a supplemental document to the QA program, the Contractor shall submit for approval of the NPC, a separate document with detailed particular requirements and specific acceptance criteria of all equipment.

At Shop

Corresponding to each major and minor equipment, the following data are required for submission to and approval of the NPC:

a. Test and inspection procedure;
b. Guaranteed technical rated or design data;
c. List of holdpoints and/or routine tests;
b. Acceptance criteria and reference standards;
c. For of test results/data with comparison to the guaranteed data. All allowable tolerances with respect to dimensional control of assemblies and sub-assemblies at shop shall be clearly indicated in the manufacturer's drawings.

At Site

The dry tests at site shall be in accordance with the latest edition of ANSI or applicable IEC Standard. Verification tests after installation shall be thoroughly discussed with the requirements similar as stated above.

The NPC or his duly authorized representative shall control said site tests, in collaboration with the Contractor's representatives.

GW-2.10.8 Reporting and Corrective Action

The Contractor's quality assurance program shall provide for prompt detection and correction of all conditions adversely affecting quality, including failures, malfunctions, incidents, trends, deficiencies, deviations, non-conformances, and defective materials. The Contractor shall establish and maintain methods for verifying and determining the cause of an adverse condition and for initiating necessary improvement and corrections to preclude repetition. Quality trends shall be analyzed to furnish a basis for improvement in work performance. The Contractor's corrective action system shall extend to the performance of other participating contractors, sub-contractors, and Contractors, when necessary, and shall provide for the interchange of corrective action information. Identification of the adverse condition, its cause, and the corrective action taken shall be recorded and reported to appropriate levels of management.

The Contractor shall establish and implement procedures for reporting, verifying, analyzing, and correcting failures, including those that occur during development and qualification testing. The procedure shall provide assurance that the cause and mode of each failure are determined, that potential safety and availability implications are evaluated, and that corrective action is taken.

A failure report shall be prepared to identify the failed item and its origin or source of manufacture and shall describe the failure, the test status at time of failure, the probable cause and mode of failure, and the recommended corrective action.

GW-2.10.9 Design Revision and Substitution of Material

Any revision affecting the design and manufacturing of the equipment as well as substitution of materials that is deemed necessary shall be notified by the Contractor to the NPC for the latter's review and approval.

GW-2.10.10 Nonconformity Handling

For nonconformity handling, the requirements of ISO 9001, Clauses 4.13 (Control of Non-Conforming Material) and 4.14 (Corrective and Preventive Action) shall apply.

The Contractor shall provide all information required to enable the NPC to evaluate the Contractor's nonconformity request.

Nonconformities which had been accepted by the NPC and decided to be "as is" shall be documented in the as-built documentation.

Nonconformities as mentioned above, which are introduced by subcontractors and their subcontractors and their subcontractors, shall also be recorded and handled by the Contractor.

Any request for the NPC's approval of a nonconformity shall be on a specific report form which shall fulfill the following requirement. The nonconformity report shall:

a. clearly state whether the nonconformity will be a permanent "as is" nonconformity or not;
b. give reference to violated requirements;
c. state whether it is violating authority requirements;
b. be justified with sufficient explanation and documentation for easy review and approval
c. clearly refers to affected area where applicable.

GW-2.10.11 Contractor's Responsibility

Approval by NPC of the Contractor's quality assurance program, quality plans and inspection and test plans or of those of his subcontractors will not relieve the Contractor of his obligation to provide goods and services which meet the requirements of the Contract.

GW-2.11 TRANSPORT, PACKING, ETC.

GW-2.11.1 General

No shipping or transport limitation shall be imposed by the NPC on the Contractor. The responsibility shall lie on the Contractor whether the dimensions of his supplied equipment and materials in crate or in box will be appropriate for loading, unloading and transported to the Site.

The Contractor must at his own expense, conduct an ocular route survey of all roads, bridges, overpasses, etc. from the Port of Entry to the Site and examine for himself the conditions of all roads and bridges.

The Contractor shall check the capacity and availability of loading and unloading facilities which will be utilized in connection with his transport operation, as well as its characteristics, taking appropriate measures to avoid damaging the same. All costs related to the reinforcement of roads, bridges and the like, if any, shall be borne by the Contractor.

The Contractor shall coordinate his own transport program and shall advise proper authorities of the transit of the heaviest items to be transported and shall comply with the instructions given by said authorities.

All damages caused to public roads, streets or public structures shall be compensated by the Contractor at his own expense.

GW-2.11.2 Packing

Each crate, box or package must have a packing list and in addition to the usual and customary marks, the following identifying marks:

Republic of the Philippines
NATIONAL POWER CORPORATION
Diliman, Quezon City

Project :

Contract No. :

Destination :

Case No. :

Gross Weight :

Net Weight :

Dimension : L x W x H

In addition, each crate, box or package shall be color coded and marked with abbreviation code to aid the NPC in sorting materials for the various substations. The identifying marks and the color codes shall be as stated in the Technical Data Sheets of the equipment.

GW-2.11.3 Transport Marking

The outside of all containers, cases, etc. shall be clearly marked with the total weight, point of maximum weight and correct position for the attachment of lifting hooks and cables and shall bear identification marks relating to the appropriate dispatch documents. Where appropriate, the cases or boxes shall bear special instructions such as **"top", "handle with care", "keep dry", etc.**

All parts of the Contracted Equipment and the Contractor's equipment shall be well-packed and protected against loss or damage during transport by sea and overland, and while in storage. Perishable material provided in spares and repair sets shall be provided in sealed containers with a shelf-life of at least ten (10) years. All packaging shall be performed in a such a way that overturning of the packages will not damage the equipment.

Instructions for handling shall be clearly marked on all parts, packages and crates.

All parts, packages and crates shall be adequately marked in order to enable identification. Each item contained in a package shall be clearly identified on the packaging list by its description and part number, package date, shelf-life and assembly drawing reference, and each item shall be marked or labeled to correspond with the packaging list.

The costs of all equipment necessary for the temporary fixing and supporting of the various parts of the Plant and the various packages to crane hooks, rail wagons, etc., during handling, transport and storage, and the cost of load distribution beams, etc., where they form part of the packages or crates, shall be included in the tender price.
The Contractor shall be entirely responsible for all packing and unpacking, and any loss or damage shall be compensated to the satisfaction of the NPC by the Contractor and, where not otherwise provided, at the Contractor's own expense.

GW-2.11.4 Preparation for Shipping and Storage

GW-2.11.4.1 Pre-Shipment Preparation

The Contractor shall prepare equipment for shipment to protect it from damage during shipment and subsequent storage not exceeding one year, unless specified otherwise in the Technical Data Sheets for each equipment under this specification.

Equipment shall be completely drained of all water and thoroughly dry prior to shipment. When such draining requires removal of plugs, drain valves, etc., the Contractor shall make sure that these parts are reinserted or reassembled prior to shipment.

All openings and machined surfaces shall be provided with protection to prevent damage, corrosion and entrance of foreign matter during shipment and storage.

Flanged connections shall be protected by a 12.5 mm or thicker plywood disc, or suitable alternate, bolted to the face of the flange.

Treaded or socket weld connections shall be protected with screwed or snap-in (snap-on) type, securely held, plastic protectors. Cast-iron plugs are not acceptable for protection unless part of the permanent assembly.

Wooden disks that cover the entire weld end area, and are secured by metal straps and fasteners shall protect butt weld connections.

Covers, straps or fasteners shall not be welded to equipment.

Equipment shall be adequately supported for shipment. All loose parts shall be crated or boxed for shipment and appropriately identified. If equipment is braced internally for shipment it shall be marked conspicuously, **"Remove internal braces before testing and operating"**.

The outside of all containers, cases, etc. shall be clearly marked with the total weight, point of maximum weight and correct position for the attachment of lifting hooks and cables and shall bear identification marks relating to the appropriate dispatch documents. Where appropriate, the cases or boxes shall bear special instructions such as **"top", "handle with care", "keep dry"**, etc.

All large and heavy shipping units shall have suitable skids for moving. Crating shall also be adequate for lifting with slings. If location of slings is critical, these locations shall be marked accordingly.

For transformers, the following provisions shall also be considered:

a. Transformer designed for oil immersed operation shall be shipped oil-filled, unless otherwise specified. Provision shall be made for oil expansion caused by temperature changes during shipment. If transformers are shipped with gas, pressure gauge for transportation shall be provided and valves shall be sealed and effectively crated to prevent tampering or removal while in transit, and a means provided for allowing gas pressure to be measured in a simple way after uncrating, without requiring release of the gas. Valves shall be securely covered by a pipe cap or other tamperproof cap. If shipped gas filled, the Contractor's recommended oil filling procedure shall be submitted for NPC's approval.

b. If transformers are shipped filled with dry air, the dry air shall have a dewpoint of -50^0F or lower, otherwise, the same provisions as for gas-filled transformers shall be followed.

c. The transformer shall be shipped with NPC accepted three dimensional impact recorders with time period recording chart of at least three (3) months for transportation on the basis of returning back after the transformer arrive at the substation site. If it is missing or damaged, if the seal is broken or it has been disturbed in any way, a specific carrier's inspection report must be issued by the Contractor's carrier to relieve the NPC of responsibility for the recorder. Instructions for the

recorder, and for special tests which may be required, are in the instruction letter enclosed in the recorder. The recorder and tape must be examined only in the presence of the Contractor or the Contractor's agent.

For the conductors, it shall be supplied on type of reels as specified in the Technical Data Sheets and shall be sturdy enough to withstand rough, but normal and customary, handling during loading, transport, unloading, field deployment and installation. The inside surfaces of the drum and flanges shall be smooth and without protrusions so that the conductor is not damaged during winding and unwinding. The cable shall be protected by plastic or other suitable material against dust and sprays (particularly salt spray). Steel-banded lagging is required on the outside of wooden flanges and between the flange I-beams of metal reels. Reels shall be marked consecutively from a production run.

Tubular bus conductors shall be packed in individual boxes. Tools shall be packed in individual boxes. Individual boxes may be shipped in larger shipping units such as containers or pallets.

All fittings, connectors, spacers and clamps shall be neatly packed in boxes or crates and shall be protected against dust and sprays (particularly salt sprays) by providing a hermetically sealed polyethylene sheet covering. Shipment without this covering will not be accepted.

All anchor bolts and accessories shall be packaged per unit structure such that a bundle shall contain the corresponding approved number of bolts and accessories.

GW-2.11.4.2 Shipping and Transportation to Site

The Contractor shall arrange and pay for the transport of the equipment, materials, etc. to the site, as well as handling and storage within the site. The Contractor shall also be responsible for the transport, handling and storage of his equipment and tools that he will be using in the installation/erection, testing and commissioning of all equipment and materials under the Contract, as well as the return of these equipment and tools to the country of origin.

The Contractor shall be responsible for making sure that shipping is arranged on vessels having suitable equipment for loading and unloading of the equipment and materials, or that harbor has the corresponding facilities.

The NPC shall approve the transport arrangements. The Contractor shall, in good time, inform the NPC about each consignment by providing a list of contents, including the shipping date and the expected date of arrival.

It shall be deemed that all costs in connection with the transport, including storage, insurance, etc., detailed above and in Conditions of Contract, being the responsibility of the Contractor, have been included and allocated in his prices stated in the Schedule of Prices.

The Contractor shall arrange and carry out under his own responsibility and supervision, the local transport from the port of unloading to the Site.

The Contractor shall gather all information and arrange for all necessary provisions in order to obtain accurate information about unloading and local transport facilities, as well as prevailing local conditions, specifically the safe load bearing capacity of public road and bridges. The Contractor shall bear every and all expenses related herewith, which shall be included in the tender.

The Contractor shall use every reasonable means and care to prevent any of the roads and bridges on the route to the Site from being damaged by any traffic by the Contractor or any of his sub-contractors. He shall select routes, choose and use vehicles, restrict and distribute loads so that any such extra ordinary traffic that will inevitably arise from the moving of the Contractor's equipment and material to or from the Site shall be limited as far as reasonably possible, and so that no damage may be caused to roads and bridges.

If, during execution of the Work or at any time afterwards, the Contractor should receive any claim arising from the execution of the Works with respect to damage to roads or bridges, he shall immediately report this to the NPC and subsequently negotiate the settlement of any payment of all sums due with respect to all claims, proceedings, damages, costs, charges and expenses in related to the claim.

GW-2.11.4.3 Inventory List

An inventory list approved by the NPC shall be furnished prior to shipment of materials and equipment, and shall consist of lists for:

a. Materials
b. Spare parts, tools and equipment
c. Test Equipment

The materials listed shall consist of an itemization of materials furnished at the factory site.

GW-2.11.4.4 Storage

The storage will be in an environment similar to the installed location, i.e., indoor equipment will be stored indoors (without heating and ventilation), and outdoor equipment will be stored outdoors. Where required to protect against condensation and humidity, a desiccant shall be provided and its presence, with the need of periodic removal and dryout, shall be so marked. When electric space heaters are provided for that purpose, these should be wired to the outside of the equipment so that energizing immediately upon receipt is possible without disassembly of crates, etc. This also requires that no combustible materials be left in the inside of the equipment.

Items which may be subjected to open storage for several months on site shall be suitably packed and protected from the weather.

The Contractor shall provide storage and handling instructions including descriptions for periodic inspection and/or storage maintenance to ascertain

that no deterioration will occur during storage. One set of these instructions shall be fastened securely to the outside of the shipping unit.

The Contractor shall provide at NPC's request, the Contractor recommended instructions for long term storage.

When equipment is specified for export shipment, the Contractor shall include packaging adequate for export shipment, and this packaging shall be such as to obtain approval and acceptance by transportation companies.

All equipment shall be shipped from the factory completely assembled as far as practicable, subject to the limitations of length, height, depth, and weight, etc. described in the Special Conditions of Contract or in the Technical Data Sheets for each of the equipment under this Specification.

GW-2.12 MISCELLANEOUS

GW-2.12.1 Contractor's Supervision

The Contractor shall provide a competent (Engineer) Service Engineer, or technician during installation and perform the complete tests, commissioning and start-up of all equipment.

The Contractor shall send only service engineer, or technician who have adequate working knowledge of the English language.
The NPC reserves the right, if services for a longer period are needed, to ask for extension of the Contractor's supervisors until such time that the NPC's personnel have been fully trained in the operation, test and maintenance of the equipment supplied by the Contractor, at no cost to NPC.

The Contractor shall notify the NPC sixty (60) days in advance of the date when the service engineer or technician should commence the installation, tests and commissioning of the equipment at the site in order for the NPC to prepare his personnel in participating such activities.

The service engineer or technicians shall not be considered employee of the NPC for all legal intents and purposes and the Contractor shall be responsible for the payment to said service engineer or technician of all indemnities accruing of any labor accident which may occur in the course of the work and for which the Contractor maybe responsible either under the Philippine Laws or any foreign laws.

GW-2.12.2 Training of NPC Personnel

GW-2.12.2.1 General

If required in the Technical Data Sheets of the equipment, the Contractor shall provide overseas and local training courses for NPC personnel in English.

Training shall be geared towards the technical engineers and maintenance personnel of NPC through the transfer of technical knowledge.

Training overseas shall include classroom instruction courses conducted on the Contractors premises during manufacture of the equipment and hands-on training to enable NPC's personnel to manage, install, test, commission, maintain, operate and service the equipment on completion of the works in accordance with maintenance and operating procedures established by the Contractor. All expenses in the overseas training shall be borne by the Contractor including airfares, accommodation, transportation and allowances.

The training overseas shall not be more than one (1) month and shall commence at the latest, two (2) months before the date of the main shipment of the equipment to be supplied. NPC shall dispatch the required number of engineers specified in the Technical Data Sheets of the equipment where training is required to attend the training at the factory sites. They should be able to see and study the equipment to be supplied to NPC.

Local training shall also be conducted for ten (10) NPC personnel for not more than one (1) month. The Contractor shall provide similar training documentation and local meals to the NPC personnel. The NPC shall provide training room and any available test facilities.

Training selected from among NPC's maintenance staff will be qualified electrical and/or electronic personnel. Their experience will be of a broad and general technical nature, including general familiarity with electronic systems and testing facilities.

The cost of performing the training course shall be included in the Contract Price for the equipment.

GW-2.12.2.2 Training Objectives

The training courses shall be designed to:

a. Enable maintenance staff to perform maintenance of the equipment by teaching principle of operation trouble-shooting methods and procedures leading to the identification and replacement of faulty piece of equipment, modules, units and components, with the objective that NPC personnel will become capable of carrying out repair and maintenance without outside assistance.

b. Enable maintenance staff to perform routine maintenance of the equipment by way of electrical and mechanical adjustments, lubrication and/or replacement of parts subject to wear or with a limited life.

c. Provide an understanding of the software and a working knowledge of the database for additions, modifications, and deletions and the practical use of diagnostic programs.

GW-2.12.2.3 Course Content

The training course shall consist of formal courses given on the Contractor's premises including classroom training, instruction and explanation during shop tests and/or Factory Acceptance Tests and practical work sessions with the Contractor's specialists during the implementation of requirements of the

Contract. Training shall be on the same hardware and software supplied under the contract.

GW-2.12.2.4 Course Documentation

The Contractor shall submit a daily schedule for the entire training period and a syllabus for each course with a listing of course documentation, no later than thirty (30) days prior to the start of training.

Documentation shall be provided covering each course to a level of detail so that the text is self-explanatory and sufficient as future reference.

Prior to the start of a course, each trainee shall receive at least one (1) set of documentation covering that course. The Contractor shall submit to NPC one (1) set of course documentation per trainee no later than fifteen (15) days prior to start of each course.

GW-2.12.3 Documentary Film

The Contractor, if required in the Bid Data Sheets of the General Requirements shall record and provide documentary film of the Scope of Works covering:

- footage on the various substations covered under this Project
- site preparation and mobilization
- processing and manufacturing of equipment to be used for the Project
- factory tests: type test, special test and routine test for the equipment that will be supplied
- equipment transport
- installation
- system testing
- commissioning of the system
- key personnel involved in the Project both on the NPC's side and the Contractor's side
- etc., which the Contractor may think would be necessary for inclusion on the documentary film.

The documentary film should last for a minimum of twenty (20) minutes and must be on a DVD type video disk on NTSC mode. Six (6) copies are to be provided by the Contractor to the NPC.

GW-2.13 MEASUREMENT OF PAYMENT

Measurement of payment for all works shall be based on the bid price of each item shown in the Bill of Quantities. The cost thereof shall cover all works required and described in the pertinent provisions of the specifications and for the satisfactory completion of each work.

SECTION VI

PART I

TECHNICAL SPECIFICATIONS

(CIVIL WORKS)

(ELECTRICAL WORKS)

SECTION VI – TECHNICAL SPECIFICATIONS

CW – CIVIL WORKS

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

CW – CIVIL WORKS

CW-1.0 GENERAL CONSTRUCTION FACILITIES

CW-1.1 Scope

This section covers the construction and/or maintenance of access roads, drainage system and other appurtenant structures, moving-in of the Contractor's construction equipment, setting up of the Contractor's camp and the disposition of the Contractor's various facilities at the end of the Contract.

CW-1.2 Moving-in

The Contractor shall bring to the site all his necessary construction equipment and plant and install all stationary construction equipment and plant at location and in the manner approved by the NPC. The Contractor shall submit sufficient detailed plans showing the proposed location of such stationary equipment and plant and other pertinent data. No installation of such stationary equipment shall be undertaken unless the corresponding plans have been approved by the NPC.

CW-1.3 Contractor's Camp Facilities

The Contractor shall provide and grade his camp site, construct his camp, employee housing, warehouse, machine and repair shops, fuel storage tanks and provide such related facilities and sanitary conveniences that the Contractor deems necessary for maintaining health, peace and order in the camp and work areas. The areas that may be used by the Contractor within the plant site shall be designated by the NPC.

The Contractor shall provide, maintain and operate, under competent direction, such camps and facilities as are necessary for the housing, feeding and accommodation of his employees.

CW-1.4 Water Supply

The Contractor shall, at his own expense, be responsible for the supply, installation, operation and maintenance of a safe and adequate supply of drinking and domestic water. Whenever there is a possibility of contamination of the water supply for drinking and domestic purposes, chlorination or some other approved methods of sterilization shall be carried out. The installation and maintenance of these services shall be subject to the approval of the NPC.

CW-1.5 Sewerage Disposal and Sanitation

The Contractor shall, at his own expense, be responsible for the installation operation and maintenance of an adequate sewerage disposal and sanitation

system and shall provide adequate toilet and wash-up facilities for his employees at his camp and in the areas where work is being carried out.

The Contractor shall execute the work with due regard to adequate sanitary provisions and applicable codes and shall take all necessary steps to prevent the pollution of water in any spring, river, or other sources of water supply. All toilets or wash-up facilities shall be subject to the prior and continuing approval of the NPC.

CW-1.6 Fire Protection

The Contractor shall observe all necessary precautions against fire, shall provide and maintain at his own expense, portable fire-fighting equipment he may deem necessary, and shall comply with all applicable laws of the Philippines relating thereto.

In the event of an uncontrollable fire occurring in the area of the Contractor's operation, the Contractor shall have to extinguish the fire immediately at his own expense, to the full extent of the manpower and equipment employed under the contract at the time of the fire.

The Contractor shall indemnify NPC against all liabilities, claims, damages and/or lawsuits arising thereto.

CW-1.7 Construction Power

0The Contractor shall be responsible for providing his own electric power supply required for construction and erection/installation. If power is available from NPC and should the Contractor elect to utilize the NPC's power supply, he shall make an arrangement with NPC concerned group as to the billing rates and other requirements needed for direct connection to NPC.

CW-1.8 Camp Security

The Contractor shall provide his own security force to the extent that he deems necessary for maintaining peace and order in the camp and work areas and to safeguard materials and equipment. Nothing under the provisions of this paragraph shall relieve the Contractor from full responsibility for the maintenance of peace and order and protection of life and property in all areas where he operates.

CW-1.9 Construction Material Storage

The Contractor is required to put up warehouse(s) with capacities sufficient to store the construction materials required in the work. The warehouse(s) shall be specifically for this contract, notwithstanding his other facilities in the site that may serve the purpose.

CW-1.10 Removal of Camp and Construction Facilities

After the completion of the work covered by the contract and prior to acceptance of the completed work, the entire camp facilities of the Contractor, including its water supply system, electric distribution system, quarters, warehouses, shops, dining halls, commissaries, temporary shed and other facilities therein shall be removed by the Contractor. The site shall be cleared and cleaned as directed by the NPC.

CW-1.11 Measurement and Payment

No separate measurement and payment will be made for the Contractor's Construction Facilities. The entire cost thereof shall be included in the various pay items in the Bill of Quantities.

CW-2.0 CARE OF WATER DURING CONSTRUCTION

CW-2.1 Scope

In accordance with the specifications contained in this section or otherwise directed, the Contractor shall construct and maintain all necessary temporary drainage ditches and other temporary protective works and he shall also furnish, install, maintain and operate necessary pumping equipment and other devices to protect construction operations free from water coming from any source, including rain.

CW-2.2 Drainage and Dewatering

The Contractor shall be responsible for dewatering foundation areas so that work can be carried out on a suitably dry condition. The Contractor shall construct drainage ditches, holes, culverts, furnish, maintain and operate at his own expense all necessary pumps and other dewatering devices to keep all work areas free from water.

After the work is completed and before it is accepted by the NPC, the Contractor shall remove all pumping equipment and shall remove, fill or plug all temporary drainage structures as directed, all at his expense.

CW-2.3 Measurement and Payment

No separate measurement and payment will be made for the Care of Water During Construction operations. The cost of furnishing, constructing, maintaining, operating and removing of temporary drainage structures, pumping system and other dewatering devices necessary to keep construction operations free from water, shall be included in the various pay items in the Bill of Quantities for structures where such care of water is required.

CW-3.0 ENVIRONMENTAL REQUIREMENTS FOR CIVIL WORKS

CW-3.1 Scope

This section pertains to the environmental and safety provisions, requirements and conditions that shall govern during the execution of all civil works under this project.

CW-3.2 General Conditions

The Contractor shall ensure compliance with the applicable environmental and safety regulations, as well as ECC conditions, during installation/construction of this project through the implementation of measures that include, but not limited to, the following:

a) Designate a Safety Officer and a Pollution Control Officer who shall respectively handle all safety and environmental concerns of the project.

b) Prepare and submit Construction Safety and Health Plan (CSHP).

c) Properly manage debris and various waste generated during installation/construction, such as the following:

- Dispose of demolition and construction debris in a designated or NPC approved disposal area(s);
- Stockpile (and cover if possible) or haul to the designated and/or pre-developed dump sites (spoil disposal areas) that shall be provided with suitable drainage – equipped with sediment traps, stripped top soil, spoils from quarry/borrow sites and excavated materials;
- Segregate solid wastes, such as empty cement sacks, scraps of tin or wood, used wires and other domestic garbage, for recycling or storage in NPC-approved temporary storage areas and further disposal to LGU-designated disposal sites.
- Properly handle, store and dispose-off, through DENR-accredited transporter/treater, hazardous wastes i.e. used oils, paints, thinner, etc.

d) Limit construction activities that generate excessive noise to daytime works only to prevent nuisance to nearby residents during rest hours.

e) As far as practicable, undertake site stripping, grading and excavations during dry weather.

f) Construction/Installation shall be carried-out in a manner where landslides and erosions are minimized.

g) Avoid unnecessary opening/clearing of areas outside construction sites or destruction of vegetative cover, especially cutting of existing trees; and to re-vegetate disturbed areas.

h) Implement biological control measures such as maintenance of vegetation buffers (i.e. sodding of grass, planting of creeping vines, herbs, shrubs and trees) to shield streams/rivers from sedimentation; planting of vegetative cover over erodible surfaces; and planting of exposed sloping areas with shallow-rooted species like grasses, herbs or creepers.

i) Locate fill slopes and spoil heaps away from drainage routes and properly remove/dispose the same as soon as practicable.

j) Preserve or replace, if practicable, natural drainage patterns (when disturbed by civil works) with appropriate drainage channels.

k) Convey oil-contaminated wastewater from workshops, garages, or gas filling stations through an oil trap (i.e. improvised oil-water separator) prior to discharge.

l) Spray water, wherever and whenever necessary, to minimize dust generation.

m) Provide PPEs and other safety provisions required by DOLE, for its project/site works.

n) Take all necessary steps to prevent the pollution of groundwater and/or water bodies in the vicinity of the project site.

CW-3.3 Measurement and Payment

No separate measurement and payment will be made for the Contractor's compliance to the foregoing. The entire cost thereof shall be included in the various pay items in the Bill of Quantities.

CW-4.0 SITE GRADING

CW-4.1 Scope

In accordance with the specifications contained herein and in conformance with the lines, slopes, grades and extent shown on the plans or otherwise directed by the NPC, the Contractor shall furnish all equipment, labor and materials and shall perform the required grading work.

CW-4.2 Clearing, Grubbing and Miscellaneous Work

CW-4.2.1 Clearing and Grubbing

The Contractor shall perform clearing and grubbing on the project site. The site shall be cleared and grubbed of all trees and brush except particular trees, which may be retained by the NPC for preservation. Particular trees to be left in place shall be protected from scarring and/or other injuries during clearing and grubbing work and other construction operations.

All stumps, roots and brush shall be removed to a depth of thirty (30) cm below original ground surface and disposed of in a place designated by the NPC. Downed timber, which may be ordered saved by the NPC for future use, shall be cut into logs as directed and neatly piled in a place designated by the NPC, otherwise they shall be disposed of same as above.

CW-4.2.2 Miscellaneous Works

Where shown on the drawings or if not shown but directed by the NPC, the Contractor shall perform miscellaneous work like demolition, removal, chipping, replacement or transfer of existing structures and other miscellaneous work. All demolished structures shall be disposed of as directed by NPC.

CW-4.3 Grading

CW-4.3.1 General

The word "grading" as defined herein means bringing to required grades all areas in accordance with the lines, slopes, elevations and grades shown on the drawings or as directed by the NPC.

CW-4.3.2 Classification of Materials

All materials in grading work shall be unclassified regardless of the nature of materials encountered during grading excavation and of materials used in grading fill. It is on the basis of unclassified material that Contractor shall determine his unit bid price for grading excavation and grading fill.

CW-4.3.3 Stripping

Fill areas to be brought to grade shall first be stripped of their top soil as directed but in no case less than twenty (20) centimeters in depth and disposed of properly in spoil areas designated by the NPC. Only materials from grading

excavation and intended to be used for filling or backfilling purposes shall be stripped of top soil in the same manner as above.

CW-4.3.4 Excavation and Fill

Areas required to be brought to grade shall be excavated or filled as the case may be. Grading work shall be carried out in such a manner that the free drainage is maintained at all times and nowhere shall pondage be found in any part of the work.

The NPC may require the modification of slopes and grades according to the conditions actually encountered during excavation, but such change or modification shall not be construed to mean by the Contractor as a basis for additional compensation over and above the contract unit prices.
Any over-excavation performed by the Contractor for any purpose or reason, except as may be ordered by the NPC, shall be at the Contractor's expense and any excess of excavation shall be refilled, where required, with approved materials that shall be furnished, place and properly compacted at the expense of the Contractor.

Unsuitable materials, as determined by the NPC, which may be encountered below established grade, shall be removed to a depth as directed and accordingly replaced with suitable materials approved by the NPC. The removal and proper disposal of such unsuitable materials shall be paid for at the contract unit price for the item, Grading Excavation, and payment for placing and compacting suitable material be made at the contract unit price for the item, Grading Fill, in the Bill of Quantities.

Fill work shall not be started until the area has been inspected and approved by the NPC. Grading fill shall be spread and compacted in layers of 15 cm. loose volume and compacted with approved roller weighing not less than 10 tons or a plate compactor for smaller areas required for compaction. Each layer shall be moistened or dried as directed for maximum compaction. No succeeding layer shall be placed thereon unless the preceding layer has been tested for compaction and approved by the NPC.

In the event that construction of concrete footing or other concrete foundations is on fill, the fill shall be compacted efficiently and thoroughly so that when the fill is tested for compaction at the required foundation elevation for the structure, the required bearing capacity is attained but in no case less than 144KPa. In no case shall filling and compaction work to be done without the presence of NPC's inspectors. The Contractor shall be held liable for any structural instability or damage that might result in consequence to non-compliance of this requirement. The Contractor shall institute corrective measures to bring the foundation base to a condition or state that will conform to the required bearing capacity; and also to repair and make good any damage on the structure to the satisfaction and at no cost to NPC.

CW-4.3.5 Slides

In the event that slides occur along excavated slopes during grading operations or after completion of grading but prior to acceptance of the work, the Contractor shall remove and dispose the slide materials and also to trim the slopes as directed to leave the slopes in a safe and neat condition all at no additional cost to NPC, unless occurrence of such slides is occasioned by causes beyond control of the Contractor. In such event, payment for the satisfactory removal and proper disposal of slide material and finishing and rounding of slopes will be paid for at the equivalent of thirty percent (30%) of the contract unit price per cubic meter for the item Grading Excavation.

CW-4.3.6 Slip-Outs

In the event of slip-outs in any part of the grading fill prior to final acceptance of the work, the Contractor shall rebuild such portion of the fill. In the case it is determined that the slip-outs was caused through the fault of the Contractor, the rebuilding of the fill shall be performed by the Contractor at no extra cost to NPC; otherwise, the reconstruction of the fill will be paid for thirty percent (30%) of the contract unit for the item, Grading Fill.

CW-4.4 Disposal

All excess materials from grading work (including excess materials in structural excavation and miscellaneous work) shall be disposed of the by the Contractor. The acquisition of the right-of-way for the area of disposal including the access thereto, permits, and other requirements, shall be the responsibility of the Contractor at no cost to NPC. The Contractor shall be held solely liable for any claim by third parties that may arise from improper transport and disposal of excess materials. The cost of acquisition of the above-mentioned right-of-way shall be included in the unit bid price for excavation.

CW-4.5 Sources of Fill Materials

When suitable materials from grading excavation are deficient to meet the quantity required for grading fill, additional fill materials shall be obtained from other sources proposed by the Contractor and approved by the NPC. Cost of excavating, hauling, placing and compacting additional materials from borrow sources shall be included in the unit price bid for the item, Grading Fill. Acquisition of right-of-way to these sources shall be the responsibility and account of the Contractor.

CW-4.6 Environmental Requirements

All construction activities to be performed by the Contractor shall be in accordance with the restrictions stated in the approved Environmental Clearance Certificate (ECC) and the conditions set forth in Clause 3.0 – Environmental Requirements for Civil Works.

CW-4.7 Measurement and Payment

CW-4.7.1 Clearing and Grubbing

Unless otherwise specified in the Bill of Quantities, no separate measurement and payment will be made for Clearing and Grubbing. Corresponding cost hereof shall be included in the unit bid price of relevant item(s) in the Bill of Quantities.

CW-4.7.2 Miscellaneous Works

Measurement for payment for miscellaneous work such as demolition, restoration, etc., shall be made on a lot basis unless otherwise specified in the Bill of Quantities. Payment will be made at the contract unit price for the item Miscellaneous Works, which payment shall cover all cost for furnishing labor, equipment and incidentals necessary for demolition and restoration, disposal, and other related works required to complete the item.

CW-4.7.3 Stripping

Unless otherwise specified in the Bill of Quantities, no separate measurement and payment will be made for Stripping. Corresponding cost hereof shall be included in the unit bid price of relevant item(s) in the Bill of Quantities.

CW-4.7.4 Grading Excavation

Measurement for payment for Grading Excavation shall be based on the number of cubic meters excavated and properly disposed. Volume shall be computed by the average end area method which shall be the volume between the original ground (as determined by survey to be made by representatives of both NPC and the Contractor) and graded surface on the drawings or as established by NPC. To this volume shall be added, for purpose of payment, all authorized excavations below grade.

Payment will be made at the contract unit price for the item Grading Excavation in the Bill of Quantities, which payment shall constitute full compensation for furnishing of all labor, construction equipment and incidentals necessary excavate, dispose and other related work required to complete the work item.

CW-4.7.5 Grading Fill

Measurement for payment for Grading Fill shall be based on the number of cubic meters of the materials placed, graded, compacted and accepted. Volume shall be computed by the average end area method which shall be the volume between the ground surface after stripping and the finished grade surfaces on the drawings or as established by NPC.

Payment will be made at the contract unit price for the item Grading Fill in the Bill of Quantities, which payment shall constitute full compensation for furnishing of all materials, labor, construction equipment and incidentals necessary to complete the work item.

CW-5.0 STRUCTURAL EXCAVATION, FILL AND BACKFILL

CW-5.1 Scope

In accordance with the specifications contained herein and as shown on the drawings and otherwise directed, the Contractor shall perform all the required structural excavation, fill and backfill for the entire project, including the proper disposal of excess excavated materials.

CW-5.2 Materials

CW-5.2.1 Structural Excavation

No classification will be made on the materials excavated. The Contractor shall determine his/her unit bid price for structural excavation based on unclassified material regardless of the nature of the materials actually encountered and excavated.

CW-5.2.2 Structural Fill

a. Sand and Gravel Fill

The material shall be of the same classification as the sand and gravel base consisting of river sand and gravel as approved by the NPC. The composite material shall be free from vegetable matter and lumps or balls of clay, and shall be uniformly graded from coarse to fine in accordance with the grading requirements shown below:

Sieve Designation (Square Mesh Sieves)	Percentage by Weight Passing
50.0 mm (2")	100
25.4 mm (1")	55-85
10.5 mm (3/8")	35-60
4.76 mm (No. 4)	25-50
2.08 mm (No. 10)	20-40
0.42 mm (No. 40)	8-20
0.074 mm (No. 200)	2-8

b. Structural Earth Fill

Structural earth fill shall consist of filling with suitable materials obtained from grading excavation or from borrow areas approved by the NPC.

CW-5.2.3 Special Foundation, if any

The NPC shall have the option to use one or both of the following materials for special foundations, whether or not shown on the drawings:

a. Lean Concrete

The strength of lean concrete shall be 13.79MPa or as designated by the NPC.

b. Selected Materials

Selected materials shall consist of compactable material which, when compacted, shall attain the required bearing capacity. The material could be a combination of earth and rock particles not greater than 8 cm including sandy clay, gravelly clay, or shale, all approved by the NPC.

Bed materials for water pipes and/or drainage culverts shall use sand fills.

CW-5.2.4 Structural Backfill

Backfill for Structures Other Than Pipes – Material for backfill shall consist of compactable and approved material taken from grading and structural excavations. Any additional material needed shall be obtained from borrow areas proposed by the Contractor and approved by the NPC.

Backfill for Sewerage and Drainage Pipes – The layer of backfill materials immediately above, up to 60 cm. from the top of pipe, and on the sides of the pipe shall consist of selected material consisting of clay soil and/or other fine materials that are free from stone particles, roots, debris. The upper layer shall consist of compactable materials taken from pipe trench and other structural excavation.

Backfill for Water Supply Pipes – Backfill for water supply pipes shall consist of compactable materials taken from trench excavation and approved by the NPC.

CW-5.3 Construction

CW-5.3.1 Excavation

a. General

The Contractor shall notify the NPC sufficiently in advance before the beginning of any excavation so that a joint survey for baseline data and cross-sectional measurements can be undertaken on the undisturbed/natural ground surface. All excavation shall be carried out according to the lines, slopes and grades shown on the drawings. In case an increase or decrease in quantities occur as a result of changes made by the NPC to such lines, slopes, and grades, the provisions on Variation Orders under the General Conditions of Contract (GCC) shall apply.

After each excavation is completed or where replacement of unsuitable material below required foundation grade has been undertaken, the Contractor shall notify the NPC so that proper inspection and confirmatory test on the bearing capacity of the foundation material can be made. In no case that concrete, sewer, drainage or water supply pipe can be placed unless a written approval has been issued by the NPC.

Over-excavation performed by the Contractor due to his carelessness shall be filled and properly compacted with the suitable material approved by NPC, at no additional cost to NPC.

b. Structural Excavation, Structure Other Than Pipes

The Contractor shall excavate the foundations to the specified side slopes and depths shown on the drawings, after which the NPC will conduct tests on the underlying material below foundation grade to determine the actual bearing capacity at such depth. If the required bearing capacity is not attained, the NPC shall instruct the Contractor to excavate further down until, in the opinion of the NPC, the bearing capacity is adequate to sustain the applied load on the foundation.

Compliance to such instruction shall not entitle the Contractor for additional compensation over and above the unit prices for excavation regardless of the nature of material excavated. For purposes of measurement, the applicable paylines for the excavation under this condition or situation shall be as shown on the drawings that show the paylines for excavation and special foundation materials.

c. Drainage and Sewerage Pipes and Cable Trench

The width of trench excavation for drainage and sewerage pipes and cable trench shall be as indicated on the drawings. All trench bottoms shall be excavated to the foundation grade indicated, regardless of the foundation material classification.

d. Water Supply Pipes

Trenches for main or feeder lines shall be excavated to the depth of no less than 0.25 meter on open ground and 0.60 meter under roadways and parking areas, both depths measured from the finished grade surface.

Service pipes shall be buried to a depth of at least 0.15 meter below grade line.

CW-5.3.2 Structural Foundation Fill

No fill materials shall be placed in any part of the fill foundation unless the foundations have been inspected and approved by the NPC. Fill materials shall be placed and spread in layer covering the entire length and breadth of the section under construction, each layer not to exceed 15 cm. in loose volume thickness and compacted thoroughly to the desired compaction as determined by the NPC. No succeeding layer shall be placed until the previous layer has been tested and approved, as to compaction, by the NPC.

CW-5.3.3 Special Foundations

If unsuitable material is encountered or if the foundation material is unsuitable such that the required bearing capacity of the foundation cannot be attained at the required elevation, further excavation shall be performed by the Contractor as stated in CW-5.3.1b.

Excavated materials below foundation grade shall be replaced at the direction of the NPC, either by lean concrete or by selected materials as mentioned in CW-5.2.3.

Selected materials shall be placed in 15-cm layers and compacted until the required bearing capacity is attained.

CW-5.3.4 Backfill

1. Structures, Other Than Pipes

Excavated areas around structures for backfilling shall be backfilled with approved materials in horizontal layers, each not exceeding 15cm. (6") in loose volume thickness. Each layer shall either be moistened or dried as directed and thoroughly tamped with tampers having no less than 160 $cm^2$of tamping area and weighing not less than 20 kg. The last layer shall be neatly brought up to the level of the adjoining finished grade surface.

In no case shall backfill be placed around concrete structures until after fourteen (14) days from placement of the concrete.

2. Drainage and Sewerage Pipes

After the pipes have been installed and grouted joints sufficiently cured, but in no case less than seven (7) days allowed for curing as specified in NSCP and the whole pipeline inspected, backfill materials specified herein shall be placed in layers as directed, each layer either dried or moistened as directed and thoroughly tamped. The backfill shall be brought up evenly on both sides of the pipe up to the top of the pipe and finally up to the finished grade surface.

3. Water Supply Pipes

After the pipeline has been installed and tested it shall be backfilled in layers as directed and compacted to the satisfaction of the NPC.

CW-5.4 Measurement and Payment

CW-5.4.1 Structural Excavation

Measurement for payment for structural excavation performed by the Contractor for structures (except drainage, sewerage and water supply pipes, and appurtenances of which cost of excavation and backfill is included in the cost of installed pipe and constructed appurtenances) will be based on the number of cubic meters of materials excavated.

For purpose of payment, all authorized excavation below foundation grade (like in the case of unsuitable materials encountered) shall be included in the measurement.

Payment will be made at the contract unit price for Structural Excavation in the Bill of Quantities, which payment shall constitute full compensation for

furnishing all labor and equipment necessary for excavation work and proper disposal of excess material excavated.

CW-5.4.2 Structural Foundation Fill

Measurement for payment for Structural Foundation Fill will be based on the number of cubic meters of fill materials placed within the neat lines as shown on the drawings.

Payment will be made at the contract unit price for the item, Sand and Gravel Fill/Base, in the Bill of Quantities, which payment shall constitute full compensation for furnishing, placing and compacting fill materials; labor which include spreading, compacting, etc., equipment and other incidentals necessary to complete the item.

CW-5.4.3 Special Foundations

Measurement for payment for lean concrete and/or selected materials placed within the pay lines for excavation will be based on the number of cubic meters in-place and accepted.

Payment will be made at the contract unit price for the corresponding item shown in the Bill of Quantities, which payment shall cover all costs for furnishing all labor, materials, equipment and tools necessary to complete the item.

CW-5.4.4 Structural Backfill

Measurement for payment for Structural Backfill (except backfill for drainage and sewerage pipes, appurtenances and other structures of which cost of backfill is included in the cost of installed pipes and appurtenances) will be based on the number of cubic meters of approved materials, backfilled, satisfactorily compacted and accepted. Any backfill material placed outside the pay lines for excavation to replace slides or over-excavation will not be paid.

Payment will be made at the contract unit price for the item, Structural Backfill, in the Bill of Quantities, which payment shall constitute full compensation for furnishing all labor, materials and equipment necessary for backfilling work.

CW-5.4.5 Trench Excavation and Backfill for Sewerage, Drainage and Water Supply Pipes and Cable Trench

No separate measurement and payment will be made for trench excavation and backfill for all sewerage, drainage and water supply pipes. Payment for trench excavation and backfill for pipes shall be included in the payment pertaining to pipes as shown in the Bill of Quantities.

CW-6.0 CONCRETE

CW-6.1 Scope

In accordance with the specifications contained in this section, the Contractor shall furnish all materials, labor, equipment and tools and perform all concreting works in accordance with the drawings, or as otherwise directed.

CW-6.2 Class of Concrete

Class of concrete or strength shall be as indicated on the drawings, which shall conform to the minimum requirement for compressive strength indicated on the provision of NSCP for Concrete and, in no case, shall not be less than 20.7 MPa.

CW-6.3 Materials

CW-6.3.1 Cement

Cement for concrete works shall be furnished by the Contractor and shall conform to the requirements of the latest edition of the Standard Specifications for Portland Cement (ASTMC150).

Unless otherwise specified, cement shall be ordinary Portland Cement. Type I for general construction which concrete is not in contact with soils or ground water and Type II for concrete in contact with soil or ground water. However, the use of Portland Pozzolan Cement Type IP meeting the AASHTO/ ASTM requirements may be allowed, provided that trial mixes shall be done and that the mixes meeting the concrete strength requirements of the AASHTO/ ASTM provisions, pertaining the use of Portland Pozzolan Cement Type IP, shall be adopted.

Changing of brand or type of cement within the same structure will not be permitted unless with prior permission and approval obtained from the NPC.

CW-6.3.2 Reinforcing Steel

The Contractor shall furnish all reinforcing steel of the sizes shown on the drawings and in accordance with the herein specifications for reinforcing steel.

CW-6.3.3 Water

Water for use in concrete shall be subject to the approval of the NPC. It shall not be salty and shall be reasonably clear and free from oil, acid, injurious alkali or vegetable matter.

CW-6.3.4 Aggregates

All coarse and fine aggregates shall consist of hard, tough, durable and clean, uncoated particles. All foreign materials and dust shall be removed by processing. Aggregates shall generally be rounded and reasonably free from thin, flat and elongated particles in all sizes and well graded from coarse to fine.

CW-6.3.5 Formwork

Timber, lumber and plywood to be used for falsework and formwork shall be sound and shall comply with the requirements of this specifications. Use forms where a smooth form finish is required. Lumber shall be square-edged or tongue-and-groove boards, free or raised grain, knotholes and the other surfaces defects. Steel when used shall conform to the requirements of the ASTM A36. Steel form surfaces shall not contain irregularities, dents, or sags.

Forms shall be wood, plywood, or steel. Wood forms for surfaces exposed to view in the finished structure and requiring a smooth form finish, shall be plywood. For unexposed surfaces, undressed square-edge lumber may be used. Forms for surfaces requiring special finishes shall be plywood, or shall be lined with plywood, a non-absorptive, hard-pressed fiberboard, absorptive-type lining or other suitable material. Plywood, other than for lining, shall be concrete-form plywood free of raised grain, torn surfaces, worn edges, patches, or other surface defects, which would impair the texture of the concrete surface. Surfaces of steel forms shall be free from irregularities, dents, and sags.

CW-6.4 Storage of Materials

CW-6.4.1 Cement and Aggregates

All cement shall be stored, immediately upon delivery at the Site, in weatherproof building that will protect the cement from dampness. The floor shall be adequately raised from the ground and in buildings placed in the locations approved by NPC. Provisions for storage shall be ample, and the shipments of cement as received shall be separately stored in such a manner that allows the earliest deliveries to be used first and to provide easy access for identification and inspection of each shipment. Storage buildings shall have capacity for storage of sufficient quantity of cement to allow sampling at least twelve (12) days before the cement is to be used. Bulk cement, if used, shall be transferred to elevated air tight and weatherproof bins. Stored cement shall meet the test requirements at any time after storage when NPC orders retest. At the time of use, all cement shall be free flowing and free of lumps.

Handling and storing of concrete aggregates shall be such that segregation or inclusion of foreign materials is sufficiently prevented. NPC may require that aggregates be stored on separate platforms at satisfactory locations.

In order to secure greater uniformity of concrete mix, NPC may require that the coarse aggregate be separated into two or more sizes. Different sizes of aggregates shall be stored in separate bins or in separate stockpiles and relatively away from each other to prevent the material at the edges of the piles from intermixing.

CW-6.4.2 Reinforcing Steel

Reinforcing steel shall be stored in accordance with the specifications for reinforcing steel.

CW-6.5 Concreting

CW-6.5.1 General

The written approval of the NPC shall be secured prior to any concreting work. All concrete shall be poured on dry and cleaned surfaces.

CW-6.5.2 Formwork Construction

Forms shall be installed mortar and watertight, true to the dimensions, lines and grades of the structure and with the sufficient strength, rigidity, shape and surface smoothness as to leave the finished works true to the dimensions shown on the drawings or required by NPC and with the surface finish as specified.

The inside surfaces of forms shall be cleaned of all dirt, mortar and foreign material. Forms, which will subsequently be removed, shall be thoroughly coated with a release agent or coating prior to its use. The release agent shall be commercial quality form oil or other approved coating which will permit the ready release of the forms and will not discolor the concrete.

Formwork for concrete placed underwater shall be watertight.

Forms shall be constructed so that the form surface of the concrete does not undulate excessively in any direction. Undulations exceeding either 2 mm or 1/270 of the center distance between studs, joints, form stiffeners, form fasteners, or wales will be considered to be excessive. Should any form of the forming system, even though previously approved for the use, produce a concrete surface with excessive undulations, its use shall be discontinued until modifications, satisfactory to NPC's Representative, have been made.

Portions of concrete structures with surface undulations in excess of the limits herein stated may be rejected by the NPC.

Form fasteners consisting of bolts, clamps or other devices shall be used as necessary to prevent spreading of the forms during concrete placement. The use of ties consisting of twisted wire loops to hold the forms in position will not be permitted.

All formworks shall be provided with adequate clean-out openings to permit inspection and easy cleaning after all reinforcement has been placed. Where forms for continuous surfaces are placed in successive units, the forms shall be fitted over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Panel forms shall be constructed so that they can be removed without damaging the concrete. All exposed joints, edges, and external corners shall be chamfered a minimum of 20 mm unless specified

otherwise herein. Forms for heavy girders and similar members shall be constructed with a proper camber.

Coating: Before placing the concrete, the contact surface of forms shall be coated with a non-staining mineral oil or suitable non-staining form coating compound or shall be given two coats of nitrocellulose lacquer, except as specified otherwise. Mineral oil shall not be used on forms for surfaces, which are to be painted. For surfaces not exposed to view in the finished structure, sheathing may be wetted thoroughly with clean water. All excess coating shall be removed by wiping with cloths. Reused forms shall have the contact surfaces cleaned thoroughly. Those that have been coated shall be given an additional application of the coating. Plaster waste molds shall be layered with two coats of the thin shellac or lacquer and coated with soft or thinned non-staining grease.

Tolerance and Variations: The Contractor shall set and maintain concrete forms to ensure that, after removal of the forms and prior to patching and finishing, no portion of the concrete work will exceed any of the tolerances specified. Variations in floor levels shall be measured before removal of supporting shores. The Contractor shall make the necessary corrective measures for the variations resulting from deflection, or when the latter affects concrete quality or curing. The tolerances specified shall not exceed by any portion of the concrete surfaces; the specified variation for one element of the structure shall be considered unacceptable when it permits another element of the structure to exceed its allowable variations. Except as otherwise specified herein, tolerances shall conform to ACI 347.

CW-6.5.3 Placing Reinforcement

Reinforcing steel and embedded items shall be properly and securely installed prior to the placing of concrete.

In no case shall concreting start without prior inspection and approval by the NPC of the placed reinforcement and other embedded items.

CW-6.5.4 Mixing Concrete

Mixing of concrete shall conform to the requirements of ACI Code for Concrete Construction.

CW-6.5.5 Placing Concrete

Concrete shall be conveyed from mixers to the forms or to the place of deposit as rapidly as possible and by methods that will prevent segregation or loss of ingredients. There shall be no vertical drop greater than 1.5 meters except where suitable equipment like metal pipe or tremie is used. The pipe or tremie shall be kept full of concrete and its end shall be kept buried in the newly placed concrete. Chutes through which concrete is delivered to the structure in a thin, continuously exposed flow will not be permitted except for very limited or isolated sections of the work.

Earth surfaces, upon which concrete shall be placed, shall be cleaned, dry and thoroughly compacted before placing the concrete.

Rock surface, upon which concrete shall be placed, shall be thoroughly cleaned of loose or semi-detached or unsound rock particles. Before placing concrete, all surfaces shall be wetted thoroughly to keep them in a completely moist condition, after which leveling mortar of the same cement ratio as the concrete mix complete contact between concrete and the leveled surface.

CW-6.5.6 Finishing Concrete

After the concrete has been deposited, distributed and vibrated, the concrete shall be struck off and screened by mechanical means approved by the NPC. The finishing machine shall be of the screening and troweling type designed and operated both to strike off and to consolidate. Hand finishing may be employed when suitable finishing machines are not available. Finishing of concrete shall be done, as directed, to the satisfaction of the NPC.

All finished surfaces shall be tested with 3 meters straight edge and any variation of the surface from the desired crown or cross section shall be properly corrected.

CW-6.5.7 Removal of Forms

Formwork shall not be removed without the permission of NPC; where such permission, however, shall not relieve the Contractor of its responsibility for the safety of the work. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete.

Falsework removal for continuous structures shall be as directed by NPC but in which case shall be temporarily supported such that the structure is gradually subjected to its working stresses. False work shall not be released in any span until the strength specified hereunder is attained.

When concrete strength tests are to be used as basis for the removal of forms and supports, the compressive strength of concrete must meet the following minimum requirements:

	Min. Time	Min.% Strength
Centering under girders and beams	14 days	80%
Sides of beams and all vertical surfaces	1 day	70%
Floor Slabs	14 days	80%

The site shall be cleared of all debris and refuse resulting from work.

CW-6.5.8 Curing and Protection

Concrete shall be cured for a period of not less than fourteen (14) consecutive days by keeping the surfaces of concrete continuously (not periodically) wet. Where tongue and groove forms were used and left in place of curing, they shall be kept wet at all times prevent opening at the joints and drying out of the concrete.

CW-6.5.9 Sampling and Testing of Concrete

The Contractor shall furnish all materials, either separately or mixed, as required by NPC. Selection of materials and the making of test specimens shall be made under the supervision of NPC and delivered to NPC laboratory or any NPC-accredited testing agency at the Contractor's expense.

The expense of making and curing all concrete specimens including the materials comprising the concrete specimens shall be borne by the Contractor. The cost of shipping and testing the concrete shall likewise be at the expense of the Contractor.

No concreting work on the project will be permitted to be done until NPC signifies in writing the approval of the use of all materials involved in making the concrete, following the satisfactory results of the necessary tests.

As work progresses, test cylinders shall be fabricated from the concrete samples and tested in accordance with ASTM C31 and ASTM C310. At least one set of four (4) cylinders shall be made from each 10 cu.m of the concrete placed of each class. Also at least one set shall be made per day for each class of concrete placed each day.

Two (2) cylinders shall be tested at 28 days for specification compliance and one shall be tested at 7 and 14 days respectively for information. The acceptance test result shall be the average of the strength of the two cylinders tested at 28 days.

The strength level of a concrete mixture shall be acceptable if every average of any three consecutive strength tests equals exceeds f'c, provided no strength test falls below fc' by more than 500psi (3.5MPa) if fc' is 5000psi or less; or by more than 0.10fc' if fc' exceeds 5000psi (35MPa)

Concrete deemed to be not acceptable using the above criteria maybe rejected unless the Contractor can provide evidence, by means of core tests, that the quality of concrete represented by the failed test result is acceptable in place. Three (3) cores shall be taken in accordance with ASTM C42 and soaked for 24 hours prior to testing. Concrete in the area represented by the cores will be deemed acceptable if the average strength of the cores is equal to at least 85% of and no single core is less than 75% of the specified strength.

CW-6.5.10 Tolerances and Repair for Concrete Construction

Concrete structures shall be constructed to the lines shown on the drawings or where so required to suit actual field requirements. Any structure that does not conform to such lines shall be repaired or removed and made anew by the Contractor at no additional cost to the Corporation.

Repairs shall be made at surface imperfections due to faulty placing of concrete and cuts on the structures due to the removal of excess concrete on the lines shown on the drawings. Such repairs shall be made immediately after early stripping of the forms, after the imperfections have been identified and the methods of repair appropriately established.

CW-6.5.11 Second Stage Concrete

The second stage of concrete finishing shall be done only after the final installation of all pertinent equipment, anchorages, pipings, conduits and other embedded items as may be required for all electromechanical works.

CW-6.6 Measurement and Payment

Measurement for payment for Concrete, except concreting works that are associated to various construction and/or installation/erection works (i.e. equipment foundation and pedestals, perimeter wall footing and posts, etc.) included in the Bill of Quantities under separate pay item, will be based on the volume of concrete placed and accepted within the neat lines of the structure as shown on the drawings or in accordance with the manner of measurement set forth in the various sections of the Technical Provisions. No deduction will be made for rounded or beveled edges or space occupied by the metal items 10 sq. cm. or less in cross section, embedded in concrete.

Payment will be made at the corresponding contract unit price for the various items of concrete shown in the Bill of Quantities. Payment shall cover all costs for furnishing all labor, materials, including equipment and tools required for concreting work. Payment shall also include non-shrink cementitious grout and epoxy grout inside foundation block out and above engine base plate and care of water.

No separate measurement for payment will be made for formworks of which the cost shall be included in concreting works.

CW-7.0 REINFORCING STEEL

CW-7.1 Description

This work shall consist of furnishing, fabricating, and placing of steel reinforcement of the type, size, shape and grade required in accordance with these specifications and in conformity with the requirements shown on the Drawings or as directed by the NPC.

CW-7.2 Material Requirement

All material shall conform to the requirements hereinafter given. Certified test reports (mill test or other) shall be submitted to the NPC for all reinforcement steel used. These tests shall show the results of all chemical and physical tests made.

CW-7.2.1 Bar Reinforcement

Reinforcement bars for concrete shall be hot-rolled, weld able, deformed billet-steel bars conforming to the requirements specified in ASTM A615 and PNS 49 unless shown on the Drawings or as required by the NPC. The use of the cold twisted bars is not permitted. Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcement Steel Institute.

CW-7.2.2 Sampling

The NPC's Representative will sample reinforcement bars at the source of supply or at the point of distribution, and the Contractor shall notify the NPC in sufficient time in advance to permit sampling and testing before shipment is made. Three (3) samples from each size shall be taken at random representing five (5) tons or fraction thereof of each size.

CW-7.3 Construction Requirement

CW-7.3.1 Order List for Bent Bars

Before materials are ordered, the Contractor shall furnish all order lists and bending diagrams for the approval of the NPC. The approval of order lists and bending diagrams by the NPC shall in no way relieve the Contractor of responsibility for the correctness of such lists and such lists and diagrams. Any expenses incident to the revisions of materials furnished in accordance with such lists and diagrams to make them comply with the drawings shall be borne by the Contractor.

Shop Drawings for Reinforcing Steel (ACI 315): Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions and details of bar reinforcing, accessories and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing steel.

CW-7.3.2 Fabrication

Bent bar reinforcement shall be cold bent as shown on the drawings or as required by the NPC. Bars shall be bent around circular pin having the following diameters (D) in relation to the diameter of the bar (d):

Bars 6mmΦ to 20mmΦ inclusive	D=6d
Bars 25mmΦ and 28mmΦ	D=8d
Bars 32mmΦ and greater	D=10d

Bends and hooks in stirrups and lateral ties may be bent to the diameter of the principal bar enclosed therein.

CW-7.3.3 Protection of Material

Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil or other foreign matter. However, when steel has on its surface easily removable and detrimental rust, loose scale or dust, it shall be cleaned by a satisfactory method, approved by the NPC.

Store reinforcement of the different sizes in racks raised above the ground with accurate identification. Protect reinforcing steel from contaminants such as grease, oil and dirt.

CW-7.3.4 Placing and Fastening Reinforcement & Miscellaneous Material (ACI-301)

All reinforcement bars, stirrups, hanger bars, wire fabric, spirals and other reinforcing materials shall be provided as indicated in the drawing or required by the specification, together with all necessary wire ties, chairs, screws, supports, and other devices necessary to install and secure the reinforcement properly. All reinforcement, when placed, shall be free from rust, scale, oil, grease, clay, and other coatings, and foreign substances that would reduce or destroy the bond. Rusting of reinforcement shall not reduce the effective cross sectional area of the reinforcement to the extent that the strength is reduced beyond specified values. Heavy, thick rust or loose, flaky rust shall be removed by rubbing with burlap or other approved method, prior to placing. Reinforcement that has bends not shown on the project drawings or on approved shop drawings, or is reduced in section by rusting such that its weight is not within permissible ASTM tolerances, shall not be used. All reinforcement shall be supported and wired together to prevent displacement by construction loads or by the placing of concrete. Unless directed otherwise by the NPC, reinforcement shall not be bent after being partially embedded in hardened concrete. Detailing of reinforcing shall conform to ACI 315. Where cover over reinforcing steel is not specified or indicated, it shall be in accordance with ACI 318.

All steel reinforcement shall be accurately placed in position shown on the drawings or as required by the NPC and firmly held there during the placing and setting of the concrete. Bars shall be tied at all intersections except where spacing is less than 30 mm in each direction, when alternate intersections shall be tied. Ties shall fasten on the inside.

Distance from the forms shall be maintained by means of stays, blocks, hangers or other approved supports. Blocks for holding reinforcement from contact with the forms shall be pre-cast mortar blocks of approved shape and dimensions or approved chairs. Layers of bars shall, be separated by pre-cast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks or metal chairs shall not be permitted. Unless otherwise shown on the Drawings or required by the NPC, the minimum distance between bars shall be 40mm. Reinforcement in any member shall be placed and then inspected and approved by the NPC before the placing of concrete commences. Bundled bars shall be tied together at not more than 1.80 meters intervals.

Reinforcement shall be placed accurately and secured. It shall be supported by suitable chairs and spaces or by metal hangers. On the ground, and where otherwise subject to corrosion, concrete or other suitable non-corrodible material shall be used for supporting reinforcement. Where the concrete surface will be exposed to the weather in the finished structure or where rust would impair the appearance or finish of the structure, all reinforcement supports, within specified concrete cover, shall be galvanized or made of a suitable non-corrodible material.

All placement or movement of reinforcing steel after placement, to positions other than indicated or specified, shall be subject to the approval of the NPC.

Concrete protection for reinforcement shall be as indicated, or if not indicated, in accordance with ACI 318.

The minimum concrete cover for reinforcement specified in the bid documents shall takes precedence over all permissible reinforcement placement variations; nothing in the variations listed below is to be constructed as permitting violation or compromise thereof:

a.	Height of bottom bars	±6mm above form
b.	Lengthwise positioning	±50mm of bars
c.	Spacing bars in walls and solid slabs	±25mm
d.	Spacing bars in beams and footings	±6mm
e.	Height of top bars	±6mm
f.	Stirrup spacing:	
	(1) For any one stirrup	±25mm
	(2) For over-all group	±25mm of stirrup

Anchors and bolts; including but not limited to those for the machine and equipment bases: frames or edgings, hangers and inserts, door bucks, pipe supports, pipe sleeves, pipe passing through walls, metal ties, conduits, flashing reflects, drains and all other materials in connection with the concrete construction shall, where practicable be placed and secured in position when the concrete is placed. Anchor bolts for machines shall be set to templates, shall be plumbed carefully and checked for location and elevation with an

instrument, and shall be held in position rigidly to prevent displacement while concrete is being placed.

CW-7.3.5 Splicing

Splicing of reinforcement shall be in accordance with ACI 318, except as indicated otherwise or modified herein. Where splices in addition to those indicated on the drawings are necessary, they shall be approved by the NPC prior to their use. Splices shall not be made in beams, girders, and slabs at points of maximum stress. Butt Splicing shall preferably be used over lapping for bar sizes larger than 32 mmΦ. Splices to be welded shall conform to AWS D1.4; certification of weld ability of the reinforcement by the manufacturer, shall be submitted to the NPC. If the Contractor elects to use butt splicing of reinforcing, he shall submit complete details of the process to be used by the NPC. If the butt splices are used the Contractor shall ensure that the splice meets the requirements specified herein by performing at least three splices which shall be submitted for tests to a testing laboratory that has been approved for such testing by the NPC. The cost of these shall be borne by the Contractor.

All reinforcement shall be furnished in the full lengths indicated on the Drawings. Splicing of bars, except where shown on the Drawings will not be permitted without the written approval of the NPC. When allowed, splices shall be staggered as far as possible and with a minimum separation of not less than 40 bar diameters. Not more than one-third of the bars may be spliced in the same cross section, except where shown on the Drawings.

Unless otherwise shown on the Drawings, bars shall be lapped a minimum distance of:

Splice Type	Grade 40 Min.Lap	But Not Less Than
Tension	24d	300mm
Compression	20d	300mm

Where d is the diameter of the bar. In lapped splices, the bars shall be placed in contact and wired together. Lapped splices will not be permitted at locations where the concrete section is insufficient to provide a minimum clear distance of one and one-third the maximum size of coarse aggregate between the splice and the nearest adjacent bar. Welding of reinforcing steel shall only be done if detailed on the Drawings or if authorized by the NPC in writing. Spiral reinforcement shall be spliced by lapping at least one and half (11/2) turns or by butt-welding unless otherwise shown on the drawings.

CW-7.4 Measurement and Payment

The quantity to be paid for shall be the calculated theoretical number of kilograms of reinforcement steel bars as determined from the net length of the steel shown on the drawings, incorporated in the concrete and accepted.
The weight of deformed bars will be computed from the theoretical weight of the same nominal size as shown in the following tabulation:

Designation	Size (mm)	Weight (kg/m)
#2	6	0.222
#3	10	0.616
#4	12	0.888
#5	16	1.579
#6	20	2.468
#8	25	3.854
#9	28	4.833
#10	32	6.313
#11	36	7.991

Clips, ties, separators and other and related materials used for positioning and fastening the reinforcement in place as required by the NPC shall not be included in the weight-calculated payment under this item. If bars are substituted upon the Contractor's request and as a result, more steel is used than specified – only the amount specified shall be included.

When laps are made for splices, other than those shown on the drawings or required by the NPC and for the convenience of the Contractor, the extra steel shall not be measured nor paid for.

The accepted quantity shall be paid at the corresponding unit price for the item, Reinforcing Steel as shown in the Bill of Quantities which price and payment shall be made in full compensation for furnishing materials, labor, equipment and incidentals necessary to complete this item.

CW-8.0 GROUTING

CW-8.1 Scope

This specification covers the requirements for the furnishing and installation of 2 component concrete epoxy grout unless shown otherwise on the design drawings.

CW-8.2 Physical Properties

The cured product shall have the following properties:
Tensile Strength = 27.65 MPa (4000 psi) min.
Compressive Strength = 63.60 MPa (9200 psi)

CW-8.3 Submittals

The Contractor shall submit copies of brochures/specifications for NPC's approval.

CW-8.4 Measurement and Payment

Measurement for payment for Grouting will be based on the number of liters placed and accepted by NPC unless otherwise specified in the Bill of Quantities. Payment shall be made at the corresponding contract price for Grouting shown in the Bill of Quantities. Payment shall include all costs including supply of labor and materials and other incidentals necessary for the completion of the work.

PART I - TECHNICAL SPECIFICATIONS

EW - ELECTRICAL WORKS

TABLE OF CONTENTS

EW - ELECTRICAL WORKS

EW-1.0 GENERAL TECHNICAL REQUIREMENTS

EW-1.1 SCOPE

EW-1.1.1 General

This Section specifies the minimum set of requirements applicable to the materials and equipment included in the scope of works under this Project. Supplementary requirements of a special nature are contained in subsequent sections.

EW-1.1.2 Scope of Works

The scope of work shall cover but not limited to the following:

1. Supply, delivery, installation, test and commissioning of one (1) unit of 10 MVA, 69/13.8 kV, 3-Ph, 60 Hz Two-Winding Transformer complete with all required accessories, appurtenances, spare and tools;

2. Temporary relocation of existing 5 MVA, 69/13.8/13.8kV, 3-Ph, 60 Hz Three-Winding Transformer including all associated accessories and other appurtenances;

3. Design, supply, erection and installation of temporary 69 kV receiving structure complete with steel pole, cross-arms, braces, bus conductor, line materials/hardware, grounding materials, line guards/covering and other accessories;

4. Design, supply, erection and installation of temporary 15 kV receiving structure complete with required pole, termination kits/lugs, grounding materials and other accessories;

5. Dismantling, re-terminate and test of existing Medium Voltage (15kV XLPE) Power Cables suitable/proper connection with the temporary relocated 5 MVA power transformer;

6. Supply, installation and test of new substation protection, monitoring and metering devices complete with auxiliary relays, instrument transformers, test blocks and other appurtenances required for the interfacing of supplied equipment;

7. Supply, installation and test of 125 Vdc battery bank complete with the required battery racks including spare parts/tools and accessories;

8. Supply, installation and test of new 125 Vdc battery charger complete with necessary devices and accessories including spare parts/tools and accessories;

9. Supply, installation and test of ground conductors, ground connectors, ground rods and other accessories required for the interfacing of the new 10 MVA Power Transformer grounding system to the existing grounding system;

10. Supply, installation and test of grounding materials for the relocated 5 MVA Power Transformer;

11. Supply, laying, tagging, bundling, termination and test of power, control and instrumentation cables for all equipment and devices of Roxas Substation;

12. Supply, installation and test of 69 kV Hard-drawn Aluminum (HAL) Bus Conductor complete with required associated line materials/hardware for the new 10 MVA Power Transformer;

13. Supply, laying, tagging, bundling, termination and test of power, control and instrumentation cables;

14. Supply and installation of embedded and/or exposed electrical metallic/non-metallic conduits, boxes, fittings and accessories for power and control cables;

15. Hauling, installation and test of existing power, control and instrumentation cables from NPC SPUG-LOD Minuyan Complex (San Jose Del Monte, Bulacan) to Roxas Substation (Roxas, Palawan);

16. Installation and test of Medium Voltage (15 kV XLPE) Power Cables to the new 10 MVA Power Transformer;

17. Dismantling and hauling of the relocated existing 5 MVA, 69/13.8/13.8kV, 3-Ph, 60 Hz Three-Winding Transformer including all associated accessories and other appurtenances to the designated stockyard inside Roxas Substation Complex;

18. Dismantling, re-coiling and stocking of the existing 15kV XLPE Power Cables (temporarily connecting the secondary winding of the relocated 5 MVA power transformer and 13.8kV outdoor switchgear);

19. Dismantling of temporary 69 kV and 15 kV receiving structures including other accessories/appurtenances which are used for the temporary relocation of the 5 MVA power transformer;

20. Dismantling, re-coiling and stocking of the existing 15kV XLPE Power Cables (connecting the tertiary winding of the 5 MVA power transformer and 13.8kV outdoor switchgear);

21. Dismantling, re-coiling and stocking of the existing 69 kV aluminum bus conductor (connecting the 5 MVA power transformer to the disconnect switch);

22. Dismantling, crating and stocking of existing substation protection, monitoring and metering devices including auxiliary relays, instrument transformers, test blocks and other appurtenances;

23. Dismantling, crating and stocking of existing 125 Vdc battery bank including battery racks and other accessories;

24. Dismantling, crating and stocking of existing 125 Vdc battery charger including other devices and accessories;

25. Dismantling, re-coiling and stocking of existing instrumentation and control cables of all equipment and devices of Roxas Substation; and

26. All other works and services including those not specifically detailed herein but are required to fully complete the project.

In addition, the following shall be provided by the Contractor:

1. Supply and delivery of spare parts and consumables as per manufacturer's recommendations and/or technical data sheets to ensure reliable operation of the equipment for at least two (2) years;

2. Supply and delivery of standard and special tools and appliances required for start-up testing, commissioning, operation and maintenance of the equipment;

3. Provision of service of highly qualified and competent engineers for the direct supervision during the test and commissioning of all supplied equipment;

4. Conduct inspection to verify and assess the extent of the related and incidental works needed to implement the project competently and efficiently; and

5. Submission of drawings and documents i.e. Equipment Manufacturer's drawings, Operation and Maintenance Manuals, Calculations, etc.

EW-1.2 WORKMANSHIP

Workmanship shall be of first-class quality and in accordance with the best modern practice for the manufacture, installation/erection, testing and commissioning of high-grade equipment, notwithstanding any omissions from these specification and drawings.

All materials supplied under this specification shall be unused, of recent manufacture, free of defects or irregularities and the best available considering durability, strength and intended service suitability and best engineering practice.

All parts shall conform to the dimensions shown on, and shall be built in accordance with approved drawings. The surface finish of all parts and components shall be in conformity with the respective strength, fit and service requirements.

Like parts and spare parts shall be interchangeable whenever possible.

Machining of renewable parts shall be accurate and to specified dimensions so that replacement of those parts fabricated or made according to dimensions so indicated in the drawings could be readily installed.

EW-1.3 MATERIALS

EW-1.3.1 Requirements to Materials

All materials to be used under this Contract shall be new, the best of their respective kinds and free from defects and imperfections. All materials shall comply with the latest revisions or edition of the specified standards for each equipment specification unless otherwise specified or permitted by the NPC.

When other standards are used, Contractor shall indicate the equivalence between the materials used and the corresponding materials following the specified standards in the equipment specification and shall obtain the approval of the NPC before starting the manufacture of the equipment and materials.

Materials and finishes selected for equipment shall be suitable for the purpose intended and for the humid tropical conditions under which the equipment is to operate. The use of other materials maybe permitted where the equipment is hermetically sealed.

Iron and steel where possible, shall be avoided in instruments and in electrical relays. Instrument screws (except those forming part of magnetic circuit) shall also be brass or bronze. Steel screws, when used, shall be zinc or chromium plated, or when plating is not possible owing to tolerance limitations, shall be of corrosion-resisting steel. Springs shall be of a non-rusting material, such as phosphor-bronze or nickel silver.

The names of manufacturers of equipment and articles contemplated for incorporation in the work together with performance capacities and other significant information pertaining to the equipment shall be furnished for approval. Equipment and articles installed or used without such approval shall be at the risk of subsequent rejections.

EW-1.3.2 Test of Material

Materials, parts and assemblies thereof entering into the work shall be tested, unless otherwise directed, according to the best commercial method for particular type and class of work. When the Contractor desires to stock material not manufactured specifically for the equipment furnished, satisfactory evidence that such material conforms to the requirements herein stated shall be furnished, in which case tests on these materials may be waived. Certified mill test reports of materials will be acceptable.

Certified copies of test reports shall be furnished in triplicate as soon as possible after the tests are made and shall be in the manufacturer's possession prior to incorporating that material in the work. The reports shall be in such form as to enable determining compliance with the applicable

specification for the material tested. When requested, tests shall be made in the presence of a duly authorized inspector.

EW-1.4 CODES AND STANDARDS

EW-1.4.1 Prescribed Standards

Unless specified otherwise in the various sections of this technical specifications for equipment, the design, materials, manufacture and testing of all works under this Contract shall comply with the latest revision or edition of the various standards specified for each equipment section of the specification.

The latest edition of each standard shall mean the latest edition available at the date of Contract signing.

In addition to the codes and standards mentioned in the technical specification for each equipment, the Contractor shall comply with all National and local laws, codes, regulations, statutes and ordinances.

Equipment or materials meeting other internationally accepted standards, which ensure an equal or higher quality than the standards mentioned, will also be accepted.

In the event of any apparent conflict among standards, codes or this specification, the Contractor shall refer the conflict to NPC for written resolution before start of fabrication. Final decision regarding the acceptance of proposed standards is the prerogative of the NPC.

No deviation from the accepted standards shall be made subsequent to the Contract without the written approval of the NPC.

Standards listed in individual technical specification are used mainly for NPC's references. Other internationally known standards however, shall also apply, provided such standards are equivalent in all respect to the standard prescribed and to the specific requirements described in the individual equipment specification. Contractor shall submit copies of such standards for NPC's review and approval.

EW-1.4.2 Designation of Trade Name or Catalog Name and Number

For convenience in designation in the Specifications, certain equipment, articles, materials, or processes are designated by trade name or catalog name and number. Such designations shall be deemed to be followed by the words "or equivalent' whether such words are shown or not, and the Contractor may offer any material or process which shall be equal in every respect to that so indicated or specified. The burden of proof of acceptability to the NPC, as to the comparative quality and suitability of alternative shall be upon the Contractor. If the Contractor's request is not approved, the Contractor shall not ask or be permitted to use the same alternative materials or equipment in modified form.

EW-1.5 INTERCHANGEABILITY AND STANDARDIZATION OF SMALL EQUIPMENT

All like parts shall be fully interchangeable with no requirement for alteration or adjustment.

The Contractor shall be responsible for the standardization of all small equipment, materials and devices he would supply. He shall arrange and perform the necessary coordination work with his manufacturers for the purposes of such standardization.

All equipment, parts and elements of mass production shall be standardized. Such items of equipment, parts and elements shall include, but shall not be limited to, the following;

- Motors
- Pumps
- Flanges
- Valves
- Bolts
- Gauges and detectors
- Electrical instruments and measuring devices
- Terminals and terminal boxes
- Primary, secondary and auxiliary relays
- Contactors, fuses and switches
- Lamps, bulbs, sockets, plugs, push button, etc.
- Lubricants
- etc.

EW-1.6 TESTS AND INSPECTION

EW-1.6.1 General

The Contractor shall provide a test specification covering all tests on Contractor's premises. Successful completion, as deemed by the NPC, of Inspection and Tests on Contractor's premises shall be a prerequisite to shipment of all materials, equipment, software or system(s). Following successful completion of inspection and tests on his premises, the Contractor shall obtain the approval to proceed with the delivery of the equipment, materials, software or system(s) from the NPC in accordance with the Technical Specification for the equipment.

The objective of the test specification shall be to set forth the means, manner and circumstances in which to verify compliance with the Contract requirements including all functional and operation performance claims for the material, components, equipment, software or system made by the Contractor and/or the original equipment manufacturer.

The test specification shall include a program for Factory Acceptance Test (FAT) and detail the following:

a. Requirements to be tested;
b. Step-by-step method of testing;

c. Expected results of tests

Approval of the test specification/procedure will not prejudice the NPC's right to order additional tests, should the NPC deem, following approval but before his acceptance of the material, equipment, software of system(s) for shipment, that certain conditions or combination of conditions were not foreseen in the test specification, in order to demonstrate that performance requirements of this Specification have been met.

Tests shall only be conducted with the aid and in accordance with test specification(s) and standards clearly identified as approved for use by the NPC, and, where applicable, employ test instruments of suitable quality calibrated to manufacturer's recommendations by a reputable agency within the previous six (6) months.

The Contractor shall provide for the expenses of unrestricted return airfare, hotel accommodation including inland transportation at the Contractor's country of origin for NPC's staff on factory acceptance tests. The trip for the factory acceptance tests will be carried out by at least two (2) of NPC's staff unless otherwise indicated in the Technical Data Sheets of the equipment for a minimum duration of seven (7) days test period or the duration of the tests as indicated in the Schedule of Timings submitted by the Contractor. Costs for these expenses shall be included in the price for the particular equipment to be witnessed by the NPC or his authorized representative(s).

EW-1.6.2 Inspection on Contractor's Premises

The NPC reserves the right to inspect all shop and assembly work associated with the Works, verify quantities consigned to stores and inspect quality control and assurance records as well as shop and purchase order records. When scheduled, and as often as the NPC deems appropriate, progress will be monitored with respect to Key Dates in the Contract Schedule and the sequence of events and activities on the Contractor's Detail Contract Schedule.

The Contractor shall demonstrate and furnish evidence that general progress is being maintained so that no activities are in danger of becoming the critical path and that specific progress of those activities on the critical path meet all target dates set by the Contractor as well as Key Dates in the Detail Contract Schedule.

The Contractor shall furnish the NPC, a list of Contractors and the components, materials, equipment or software to be furnished by them for use in the Works, in sufficient time to permit inspection and testing of all components, materials, equipment and software. Purchase Orders shall clearly indicate level of inspection to which purchased items will be subject.

All shop orders or instructions to production and manufacturing departments shall quote the pertinent requirements of the Specification and shall bear a suitable notation advising quality control inspection requirements. A system for advising the quality control department of same shall exist. If so requested by the NPC, the Contractor shall furnish triplicate copies of the designated internal orders and instructions.

EW-1.6.3 Tests on Contractor's Premises

EW-1.6.3.1 Routine Tests

The Contractor shall perform routine tests in accordance with requirements of the Specification and the Contractor's test specification approved by the NPC. The Contractor shall give the NPC access to Works to determine or assess compliance with the provisions of this Specification or to witness Contractor's routine shop tests. The Contractor shall submit results of routine tests within fifteen (15) days after performance of the tests.

EW-1.6.3.2 Type Tests

The Contractor shall carry out all type tests called for in this Specification and such tests in the Standard in accordance with criteria and to the extent specified in the Specification and on custom manufactured items as called for by the NPC to obtain required performance data.

Upon submission of relevant test certificates from an independent testing agency approved by the NPC, and proof that the equipment to be tested is identical to that covered by the test certificates, the NPC will waive the requirements for corresponding type tests called for in this Specification and/or specified in the Standards.

EW-1.6.3.3 Factory Acceptance Tests

Prior to shipping and final inspection, tests hereinafter referred to as Factory Acceptance Tests (FAT) shall be conducted by the Contractor at his plant and will be witnessed by the NPC.

The Contractor shall carry out tests, as may be required by the specified Standards and the Quality Control and Assurance Program, as well as the entire test program, approved by the NPC, prior to the witnessed FAT, remove all faults found and correct all failures so that to the best of his knowledge, no functional or procedural errors will occur during the witness FAT.

At the commencement of the witness FAT, all equipment shall be brought together in one place, integrated and the configuration/set-up at the factory site shall be identical to that to be installed at the site and any equipment and software necessary for the proper operation of the equipment shall have reached its final form, not to be changed during the FAT and until commencement of commissioning at site.

The Contractor shall immediately advise the NPC should failures occur, take remedial action subject to the NPC's approval and proceed with the FAT as and when directed by the NPC. It shall be the NPC's prerogative to order a repeat of all such tests that he deems may have been affected by the failure.

The Contractor shall ensure that during the test, all hard copy from output devices is retained and that no outside parties interfere in any way with testing, equipment or test instruments, fixtures and jigs for the entire duration of the FAT. Only Contractor's personnel who are needed on the testing of the

equipment shall be allowed in the test area. The Contractor shall appoint a chief-tester who shall be responsible for conducting the test, ensuring at all times that the test instruments, fixtures, jigs and extender cards, and those of the Contractor's personnel who in any way may contribute to the test, including testers, specialists and maintenance personnel are available prior to scheduled commencement of each test or as and when instructed by the NPC.

The chief-tester shall also be responsible that an accurate record of tests is kept and each individual test is duly initialed and dated by the tester and marked either passed or failed with annotations of antecedents and observations concerning the test. For each day of testing, the chief-tester shall submit to the NPC the proposed disposition of each criterion that failed during the previous day of testing, prior to commencement of the tests scheduled for that day. Tests witnessed by the NPC will be initialed accordingly by him on the test record. The test record and dispositions, and any other pertinent supporting data and documents shall form part of a test report to be submitted in accordance with the specification.

Material, equipment, software or system(s) shall be required to pass one complete run of functional tests with satisfactory results and shall have all faults and failures corrected, if any. At completion of all tests, as well as at any time during the test at the NPC's discretion, test results, except for the parts comprising dynamic data, shall be compared with the reference copy. If no differences are detected and all tests have demonstrated compliance with the requirements of this Specification, then the FAT will be deemed successful.

EW-1.6.3.4 Tests Failures

If any equipment fails to pass any test, the NPC may, at his own judgment, direct the Contractor to make any necessary corrections or alterations to it for minor defects or to replace it forthwith for major defects. Any and all expenses that might result by the supply and installations of new parts or by modification of existing parts and any and all expenses resulting in additional tests made necessary by failure of equipment to meet the guarantees and other requirements of the specification shall be borne by the Contractor. The costs of witnessing the Factory Acceptance Tests by the NPC or his representative(s) as a result of re-test to be conducted on the equipment shall also be borne by the Contractor.

EW-1.6.4 Field Test

Field tests and acceptance tests shall be performed by the Contractor and witnessed by NPC's representative to determine whether requirements of the specification have been fulfilled. The Contractor shall provide instructions and acceptance criteria for field testing for NPC's review and approval prior to conduct of such tests and commissioning the equipment. No field tests shall be performed unless approved by the NPC.

EW-1.6.5 Test Reports/Certificates

Six (6) certified copies of the reports of all NPC's specified tests and other manufacturer standard tests shall be furnished to the NPC immediately within a maximum of fifteen (15) days following the completion of the tests. For equipment which had the required type test already, the type test certificates shall be submitted by the Contractor together with his proposal.

For the routine tests, acceptance tests and field tests, the test certificates shall include, in addition to the test results, the following information:

a. Date for the test certificate
b. Equipment data
c. NPC's reference number
d. The equipment serial number

Certified test data submitted to NPC shall also include copies of oscillographic records made in conjunction with the tests, and certification that all equipment furnished are suitable, when energized at continuous voltage, and for manual washing using a single-stream high pressure nozzle.

The Contractor shall bear the cost of furnishing these records and reports.

EW-1.6.6 Waiver of Factory Acceptance Tests Witnessing / Inspection by NPC

Where Factory Acceptance Tests (FAT) to be witnessed by NPC's representative(s) have been required in the Technical Data Sheets of a particular equipment, costs of these tests witnessing shall be deemed included in the price for the equipment.

However, if the NPC opted not to witness the Factory Acceptance Tests, NPC will issue a Certificate of Waiver of Tests Witnessing/Inspection for the equipment and materials. In such case, the Contractor shall proceed with the Factory Tests in accordance with the requirement of the specification and the manufacturer's test specification as approved by the NPC.

Where Factory Tests are not required to be witnessed by NPC's representative(s) as indicated in the Technical Data Sheets of the equipment, a Certificate of Waiver of Tests Witnessing/Inspection will be issued also by the NPC. In this case, no claim whatsoever can be made by the NPC on the Contractor as a result of waiving the Factory Acceptance Tests.

EW-1.7 ELECTRIC WELDING

EW-1.7.1 Welding Procedure

All welding shall be performed in accordance with a procedure which shall be in accordance with standards equal to those required by the "Standard Qualification Procedure" of the American Welding Society.

EW-1.7.2 Acceptance of Welded Structures

The acceptance of the welded work shall depend upon correct dimensions and alignment and absence of distortion in the structure, upon satisfactory results from the examination and testing of the joints in accordance with the instructions given on the drawings and the soundness of the welds and upon general good workmanship.

EW-1.7.3 Cleaning

All excess weld materials, slag, splatter and flux residues shall be removed from the steel work.

EW-1.8 TROPICAL SERVICEABILITY

EW-1.8.1 General

In choosing materials and their finishes, due regard is to be given to the humid tropical conditions under which equipment is to work. Some relaxation of the following provisions may be permitted only when equipment is hermetically sealed but it is preferred that tropical grade materials should be used wherever possible.

Cubicles used for switchgear and control cabinets in outdoor plant shall be vermin-proof and fungus-proof.

Totally enclosed motors and enclosures containing electrical control and switching equipment and instrument for outdoor installations shall be equipped with temperature controlled electrical heaters. The construction of the enclosures and installation of heaters shall be as to ensure effective circulation of air while ensuring that no damage to equipment occurs due to overheating.

The Contractor shall supply the NPC with detailed descriptions of all design characteristics necessary to fulfill the requirements in connection with the tropical conditions under which the equipment will be operated.

EW-1.8.2 Metals

Iron and steel are in general to be galvanized or painted as appropriate. Small iron and steel plate (other than SUS 316 stainless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts or relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores or other components which are laminated, or which cannot be rustproofed, shall have all the expected parts thoroughly cleaned and heavily enameled, lacquered or compounded. Where it is necessary to use dissimilar metals in contact, these should, if possible, be so selected that the potential difference between them in the electrochemical series is not greater than 0.5 volt. If this is not possible, the contact surfaces of one or both of the metals are to be electroplated or otherwise finished in such a manner that the potential difference from each other by an approved insulating material or a coating of approved insulating varnish.

EW-1.8.3 Screws, Nuts, Springs, Pivots, etc.

The use of iron and steel is to be avoided in instruments and electrical relays wherever possible. Steel screws, when used, are to be zinc or chromium plated or, when plating is not possible owing to tolerance limitations, are to be of corrosion-resisting steel. All wood screws are to be of dull nickel plate brass or other approved finish. Instrument screws (except those forming part of a magnetic circuit) are to be brass or bronze. Springs are to be of non-rusting materials, e.g., phosphor bronze or nickel silver, as far as possible. Pivots and other part for which non-ferrous material is unsuitable are to be of an approved rustproof steel where possible.

EW-1.8.4 Fabric, Cork, Paper, etc.

Fabrics, cork, paper and similar materials, which are subsequently to be protected by impregnation, are to be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or linseed oil varnishes are not to be used.

EW-1.8.5 Wood

The use of wood in equipment is to be avoided as far as possible. When used, woodwork shall be of thoroughly seasoned teak or approved wood which is resistant to fungal decay and shall be free from shakes and warps, sap and wane, knots, faults and other blemishes. All woodwork is to be suitably treated to protect it against the absorption of moisture, the growth of fungus and termite attack, unless it is naturally resistant to these causes of deterioration. All joints in woodwork are to be dovetailed or tongued and grooved as far as possible. Metal fittings where used are to be of non-ferrous material.

EW-1.8.6 Adhesives

Adhesives are to be specially selected to ensure the use of types which are impervious and resistant to attack of mildew and insects. Synthetic resin cement only shall be used for joining wood. Case-in cement shall not be used.

EW-1.9 ENVIRONMENTAL REQUIREMENT AND OPERATING ENVIRONMENTAL CONDITIONS

EW-1.9.1 General

All equipment shall conform with the environmental requirements and conditions applying to the location where it is to be used. Additional heating by equipment inside buildings must be taken into account.

All equipment and materials to be furnished shall meet the performance and rating requirements of this specification and all Contractor's guarantees shall be based on operation within the environment specified in the Technical Data Sheets of the equipment. This also applies during storage and if susceptible to moisture absorption or fungus attack, the equipment and materials shall be

treated with fungicidal varnish and otherwise be adequately tropicalized as specified in Section EW-1.8.

Special measures shall be taken such as the use of chemically inert parts and proper surface preparation and paint application in accordance with this Specification for equipment installed at Site(s) with a corrosive atmosphere, to protect exposed metal parts and other materials susceptible to chemical reaction.

Materials susceptible to deterioration from climatic conditions or subject to the formation of fungus or any other form of parasitic life shall preferably not be used, but if used and cannot be avoided, these must be permanently protected.

For all outdoor equipment, the operation of the equipment must not be influenced by dew, fog, rain, wind, sun radiation, quick changes of temperature, dust, smoke, salts, aggressive gases, and steams. Outdoor installations shall be protected against solar radiation by means of adequate covers, where required, with non- deteriorating material to be provided by the Contractor.

EW-1.10 SEISMIC REQUIREMENTS

Equipment and equipment supports shall be designed to withstand and maintain their structural integrity when exposed to seismic loading/seismic factor specified in the Technical Data Sheets. It shall be designed to resist a lateral seismic force and remain in place in accordance with the requirements of the latest issue of Uniform Building Code (UBC), Section 2312g.

The Contractor shall demonstrate the equipment's ability to withstand and maintain its structural integrity when subjected to the forces resulting from the seismic conditions specified herein. This can be accomplished in one or a combination of the following methods:

a. Predict the equipment's performance and response to a seismic force by mathematical static analysis;
b. Test the equipment under simulated seismic conditions (static or dynamic testing); or
c. Utilize previous seismic qualification of the equipment and demonstrate applicability under the seismic conditions specified herein.

The seismic loading on the equipment and its supports shall be obtained by multiplying the weight of components by the horizontal seismic acceleration coefficient (H). The force shall be assumed to act in any lateral direction.

Where: $H = 0.5 \times Z \times I$
Z = Uniform Building Code coefficient corresponding to the zone where the equipment is located
I = Importance Factor

Equipment and supports shall be designed for lateral forces in accordance with the following formula derived from the UBC:

$$Fp = HWp$$

Where:

Fp = lateral force on the equipment
Wp = the total weight of the equipment supplied by the Supplier
H = Horizontal seismic acceleration coefficient given in the above formula

Support design shall not include friction in resisting the lateral shear load.

The maximum stresses, under seismic loading combined with all other load effects, shall be within the normal allowable material working stress limits as set forth in the appropriate design standards and codes listed in this specification.

Deformations resulting from the combined influence of normal operating loads and seismic loads shall be investigated to verify that they will not impair structural integrity.

The Contractor shall submit a certification stating that the equipment can resist the forces resulting from the seismic conditions specified herein and remain in place. The Contractor shall submit the following data and documents for NPC's information:

a. Outline arrangement drawing showing all pertinent dimensions and support locations

b. Analytical method and procedures in a step-by-step form which is readily auditable by persons knowledgeable in such analysis

c. Results of analysis and conclusions

EW-1.11 CLEANLINESS

At time of shipment, the equipment shall be clean inside and outside.

All waste such as metal chips or filings, welding stubs, dirt, rags, debris and any other foreign material shall be removed from the interior of each component. All mill scale, rust, oil, grease, chalk, crayon or paint marks and other deleterious materials shall be removed from all interior or exterior surfaces.

Solvent cleaning, if required, shall be performed in accordance with SSPC-SP1.

Heavy cleaning, if required, shall be performed in accordance with SSPC-SP3.

Cleaning of stainless-steel surfaces shall be performed with solvents, cloths and abrasive that do not contain halide. Only stainless steel, clean, iron-free, hand or power tools and aluminum oxide abrasive shall be used on stainless steel components. Materials used to clean carbon steel or cast iron shall not be used to clean stainless steel surfaces.

EW-1.12 SURFACE TREATMENT AND CORROSION PROTECTION

EW-1.12.1 General

Equipment and all steel parts shall be painted, hot-dip galvanized or treated with protective coatings to prevent corrosion and provide a smart and pleasing appearance. This work shall comprise the surface treatment, priming and application of paint or metallic coatings in the workshop and at the site, including all paint repair works that may be necessary. Corrosion protection shall include the steel surfaces of structures cast into concrete.

The works of corrosion protection shall include all equipment and installations for sand blasting and paintings.

The Contractor shall furnish, with his proposal, a complete description of the corrosion protection he intends to provide. After purchase order, the Contractor shall submit applicable cleaning and coating procedures and specific description of coating material to be used.

Where possible, equipment shall be designed such that all surfaces can be finish-coated or recoated after erection at the site.

EW-1.12.2 Requirements to the Finished Coating

All finished surfaces shall be level and free of tears, burrs, clots and impurities. The coat of paint shall be of even thickness, also in corners and on edges. Moreover, all finished surfaces shall be uniform in respect of color and gloss.

The paint film, under visual examination, must in any case present the appearance of an accurate application and be free of lesions, porosity, cracks or bubbles.

Any damage during transport, mounting, welding, etc. shall be repaired by Contractor. Repair methods shall be submitted for approval of the NPC. This also applies to damages to components supplied by a sub-contractor.

EW-1.12.3 Guarantees

The guarantee period of the paint work shall be two (2) years. During this period, it will be the responsibility of the Contractor to repair or replace without charge all paintwork showing defects (such as discoloration, peeling, wrinkles, bubbles, flakes or rust, etc.) where it may be proven that the deterioration arises from:

a. Poor quality paint;
b. Insufficient cleaning of the surface before painting;
c. Incorrect choice of paint for the service required; and
d. Incorrect application of paint itself to the surface.

In such cases, the Contractor shall take charge of restoration of all parts which have shown defects.

For the guarantee against corrosion penetration, the NPC requires a ten-year guarantee period. The rust penetration shall be measured according to ISO 4628/3-1982. After ten years, the rust penetration shall not exceed Ri 2. Ri 3 penetration shall entitle the NPC to repair the surface at the expense of the Contractor.

The guarantee shall commence on the day of the issuance of the Certificate of Provisional Acceptance.

EW-1.12.4 Reference Standard

Except otherwise specified elsewhere in the specification, the surface treatment and corrosion protection for all metal parts shall be in conformity with the latest revision of the standards listed below:

ASTM 123	Zinc (hot-dip galvanized) coating on Iron and Steel products
DIN 55928	Protective painting of steel structure instructions
DIN 55945	Painting Materials – Notions
DIN 18363	Paint work – Buildings
DIN 18364	Surface Protection Work for Steel
DIN 53210	Determination of Rust Degree
DIN 55151	Determination of Adhesion
ISO 4628/3	Determination of Rust Penetration

Other internationally known standards however, shall also apply provided such standards are equivalent in all respect with the reference standards prescribed above. The Contractor shall submit copies of such standards for NPC's review and approval.

EW-1.13 EQUIPMENT DESIGNATION (EQUIPMENT MARKING)

EW-1.13.1 Identification System

All equipment and all component parts including cables, control wiring and terminals shall be designated with an alphanumeric code allowing clear identification of the equipment and components during design, installation and operation of the plant/substation. Equipment, cables, control wiring and terminals shall be systematically marked, both on the drawings and documents and on the equipment, cables, wires and terminals themselves.

Equipment designation codes shall be indicated on all planning documents including bills of materials, lists of spare parts, etc. The codes will later be used for easy identification of stored equipment parts and materials and shall be suitable for use with a computer supported registration system.

Tender drawings are in some cases already marked with designated codes; the system shall be expanded to include detailed diagrams, cable lists, spare parts list, etc. approved by the NPC.

Wherever applicable, labels/plates bearing the E.D.S. code shall be attached to equipment in the Contractor's works.

The material and fastening methods proposed for E.D.S. labels/plates are subject to the approval of the NPC.

EW-1.13.2 Labels and Plates

A stainless-steel nameplate or equivalent anti corrosive nameplate with clearly legible writing shall be permanently attached to each assembled piece of equipment at an easily visible place. It shall provide all necessary information pertaining to the equipment, but as a minimum, the following must be included: Manufacturer's name, type of equipment, serial number, year of manufacture, project identification number, weight, E.D.S. code and other relevant information in compliance with applicable standards. Any special maintenance instructions shall also be shown at this or other suitable location.

For other major components i.e., pumps, motors, etc., the following shall be added: Rated HP, speed, total head, capacity, direction of rotation, and any other pertinent information.

If it is not practical to include NPC's equipment identification, or tag number on the equipment nameplate, then a separate durable stainless-steel tag with NPC's identification number shall be provided and securely attached to the equipment.

Labels shall also be provided for equipment and devices mounted on control boards, relay cabinets, desks and other places as required for proper identification, as well as for operational, functional and safety reasons. The labeling, size of label-plates and their location shall be subject to approval by the NPC. A sample label-plate (with indication of material used) with lettering shall be submitted for this purpose.

Each equipment wherever necessary, shall be provided with cautionary and warning plates and signs in accordance with the prescribed ANSI/IEEE or equivalent IEC Standards for the particular equipment. Nameplates, labels and warning plates shall be in English.

EW-1.14 SPARE PARTS AND SPECIAL TOOLS

A list of mandatory spare parts and special tools to be supplied by the Contractor is specified in the Technical Data Sheets for each of the equipment under this specification. If in case any of the mandatory spare parts or tools are not applicable to his supplied equipment, the Contractor is required to provide an alternative spare parts and tools that are applicable to his supplied equipment with the same quantities as required. The NPC has the option to choose in the list of the recommended spare parts and tools given by the Contractor the replacement for the mandatory spare parts and tools, which the Contractor failed to offer or provide an alternative replacement.

In addition to the above, the Contractor shall also include with his Proposal, a list of recommended spare parts and special tools which he considers necessary for the safe and reliable operation and maintenance of the equipment. The Contractor shall indicate the expected life of the parts requiring replacements and the minimum recommended inventory of the

spare parts for installation, start-up, continuous operation and maintenance. Contractor shall state whether the recommended spare parts is a stock item or a special item, and shall furnish name and location of the nearest Contractor, and approximate lead time required for delivery. The NPC has the option to consider or not to consider the recommended spare parts and tools as given by the Contractor with the corresponding price.

All spare parts shall be readily interchangeable with the ones which they are to replace. They shall be of the same material, of identical size and manufacture and shall have the same properties as the corresponding parts of the installed equipment. Specified conditions relating to tests, treatment of surfaces and painting, etc. of the installed equipment shall also apply to spare parts.

All spare parts shall be properly packed (and where necessary treated) in such a manner as to allow prolonged storage at the Site, considering the ambient conditions prevailing there. In due time, the Contractor shall inform the NPC of the eventual precautions to be taken for the proper storage of the spare parts.

The Contractor shall provide a spare parts list containing at least the following information:

- Name and address of manufacturer and other identification no.
- Item description including EDS-code, drawing no., material designation, units to be ordered.
- List of items (designated by EDS-code) for which the respective spare parts can be used.
- Item price.

EW-1.15 GENERAL ELECTRICAL REQUIREMENTS

EW-1.15.1 General

The supply of the electrical equipment for high and low voltage installation shall be complete to the extent required to put the substation(s)/power plant(s) in satisfactory operating conditions, with all the requirement completely connected and interconnected with operating switches, interlocks, signalization, alarms and metering instruments.

The Contractor must supply all minor items (such as auxiliary relays, terminal blocks, accessories, etc.) which are necessary although not expressly described in the Technical Specifications, in order to guarantee the trouble-free operation and ease in the maintenance of the supplied substations/switchyard (or parts of substations/switchyard) with particular reference to the provisions to be taken in order to avoid dangerous or wrong operations.

The electrical equipment shall be designed in such a way as to bear without damage and permanent deformation the consequences of over-voltage of internal or atmospheric origin and short circuit calculations shall be provided, giving full evidence, that each electrical component can withstand the maximum stresses under fault conditions, e.g., upon failure of the

corresponding main protection device and time-delayed fault clearing by the back-up protection device.

Outdoor installations shall be protected against solar radiation by means of adequate covers, where required, with non-deteriorating material to be supplied by the Contractor.

The Contractor shall ensure, that all equipment supplied is insensitive to any signals emitted by wireless communication equipment.

All the metallic frames of the electrical equipment shall be securely connected to the general earthing system in compliance with accepted Standards.

EW-1.15.2 Insulation Levels

The insulation levels for different system voltages shall be as indicated on the particular Technical Data Sheets of the equipment.

EW-1.15.3 Minimum Clearances

The center-line spacing and clearances above ground level of the conductors shall be as shown on the bid drawings, or in the absence of such information, shall match the ANSI Standards.

Clearances of energized metal parts are summarized in the following table for the different systems:

Nominal System Voltage	*d1 (mm)*	*d2 (mm)*	*D (mm)*	*H (mm)*
13.8	300	350	900	3500
34.5	500	610	1500	3600
69	800	900	2000	3750
115	1100	1360	2500	4000
138	1300	1800	3000	4000
230	1850	3200	4000	5000
500	3250	5200	8000	9000

where:

d_1 = minimum clearance between live metal parts and ground
d_2 = minimum clearance between live metal parts of two phases
D = practical distance between phase center lines
H = minimum height of live conductors above ground.

However, the upper edge of an earthed insulator support must, for all voltage series, beat a height of at least 2300 mm above the ground level.

EW-1.15.4 Creepage Distances

Creepage distance of bushing of equipment, string of insulators, station post insulators and rigid support insulators shall comply with the requirements stipulated in the Technical Data Sheets of the equipment.

EW-1.15.5 Levels of Equivalent Salt Deposit Density (mg/cm^2)

The level of equivalent salt deposit density shall be as stated in the Technical Data Sheets of the equipment.

EW-1.15.6 Auxiliary Services Voltages

The auxiliary equipment shall be designed for the conditions of voltage and frequency mentioned in the Technical Data Sheets of the equipment.

EW-1.15.7 Color Standard

Each equipment shall be painted in accordance with the Standard specified below.

Equipment	*Color*
Outdoor equipment	RAL 7035
Indoor Equipment (including Inside cubicle)	RAL 7032

EW-1.15.8 Color and Code of Phase Indication

Color and code of phase indication shall be as follows:

Phase	Color	Code
First phase	Red	A
Second phase	Yellow	B
Third phase	Blue	C

EW-1.15.9 Equipment Number Plates

The Contractor shall furnish outdoor equipment number plates as required by the NPC. Equipment numbers are shown in the Bid Drawings "ONE LINE DIAGRAM" of each substation/switchyard. The equipment number plates shall be clearly visible to a man standing on the ground even at a distance and shall be made of weather resistant materials. This is in addition to the equipment marking to be supplied by the Contractor as mentioned in Section EW-1.13.2.

EW-1.15.10 Phase Indication Plates

Phase indication plates shall be provided on the substation steel structures to indicate the phases of bus, incoming lines and transformer feeders.

Color and codes of phase indication plates shall be as follows:

Phase	Color	Code
A - Phase	Red	A
B - Phase	Yellow	B
C - Phase	Blue	C

The color and code letters shall be luminous and shall be placed at easily recognizable position. The plates shall be made of weather resistant materials.

EW-1.16 PROTECTION SYSTEM REQUIREMENTS

EW-1.16.1 General

The supply of the electrical equipment for high and low voltage installation shall be complete to the extent required to put the substation(s)/power plant(s) in satisfactory operating conditions, with all the requirement completely connected and interconnected with operating switches, interlocks, signalization, alarms and metering instruments.

The Contractor must supply all minor items (such as auxiliary relays, terminal blocks, accessories, etc.) which are necessary although not expressly described in the Technical Specification, in order to guarantee the trouble-free operation and ease in the maintenance of the supplied substations/switchyard (or parts of substations/switchyard) with particular reference to the provisions to be taken in order to avoid dangerous or wrong operations.

The electrical equipment shall be designed in such a way as to bear without damage and permanent deformation the consequences of over-voltage of internal or atmospheric origin and of the short circuit currents within the limits stated in the Technical Specification.

All the metallic frames of the electrical equipment shall be securely connected to the general earthing system in compliance with accepted Standards.

EW-1.16.2 Protection Design Criteria

The functional requirements of this specification relating to protective relaying shall apply to all equipment on which the protective function is dependent. They shall thus also apply to parts which are not directly related to the protective relays, such as functions in the auxiliary power distribution, interface cubicles, etc., included in the relay protection function.

Strict demands shall be made on selectivity in isolation. To improve security, protection systems should be designed to isolate only the faulted portion of the network. For faults external to the protection zone, the protection system should be designed either not to operate, or to operate selectively with other systems, including breaker failure.

All primary faults which are of such magnitude that they jeopardize operation of the grid, which represent a risk to personnel, or which could cause appreciable material damage to plant or to the whole system, shall be isolated or relived of stresses in a controlled way even in the event of a single failure in the relay protection equipment, its supply of measuring quantities, auxiliary voltage, etc., or primary breakers.

When required, every fault condition shall be detected by at least two fast primary protection systems with different measuring principle.

Primary and back-up protection, including the auxiliary supply, shall be physically and electrically separated to allow maintenance on one protection without affecting the function of the other.

To improve dependability, the two protection sets shall be divided into two electrically and mechanically separated parts by means of:

- separated d.c. power supply
- separated boards
- separate current transformer cores
- separate voltage circuits
- separated tripping devices
- separated cables
- separated relay protection channels (only for lines)

To improve dependability, each primary protection shall have separate tripping paths to the circuit breaker, that is one primary protection set to actuate trip coil number 1 only and the other protection set to actuate trip coil number 2 only. Cross-tripping is not allowed.

Each protective relay shall be equipped to indicate the trip on the respective alarm relay rack.

The protection system shall be arranged for complete subdivision in two parts (relay set 1 and 2). Protective relays belonging to relay set 1 and 2 must not be fitted in a common panel unless otherwise indicated in the Technical Data Sheets of the respective Sections. Communication between the two subdivisions shall be transferred via barrier relays.

Each feeder shall have a separate protective zone. Each feeder protective relay shall trip only the breaker or breakers associated with that feeder. Selective tripping of all circuit breakers within the protected zone shall be guaranteed.

All protective relays shall be microprocessor based, numerical design if required, modularized plug-in type and placed in standard 19-inch racks (Other relays, where instructed, shall be mounted on the rear panel of a duplex control switchboard. All accessories necessary for this type of mounting shall be provided with the relays). If required to be coupled to substation control system through a microprocessor-based substation control and protection system, all relays shall be numerical in nature with serial communication facilities.

The fault detection and maintenance shall be easy. Suitable facilities shall be provided on each measuring relay or system to disconnect the trip outputs, and to subsequently short and disconnect the current transformers. These shall also disconnect any voltage transformer, alarm or critical d.c. circuit, without affecting any other devices. Removal of any relay or system component directly connected to any CT circuit shall short out the relevant CT connection.

All relays shall be wired and preferably automatically tested at the factory. Plug-in elements shall have reliable devices for fixing them in the service position.

Breaker failure protection, if required, should be provided to detect stuck breaker condition and initiate tripping of breakers adjacent to stuck breaker, including line remote breaker to improve dependability. DC supplies to the breaker failure protection should be separate from the breaker trip coils dc supplies and from other protection system dc supplies. Generally, only one breaker failure protection system is provided.

Protection systems should not operate for stable power swings. Also, protection systems should not impose limitations under normal or short-time contingency circumstances.

To shorten overall operating times, protection schemes should utilize, where required, differential relaying, communication based relaying and instantaneous overcurrent relaying to the maximum possible extent, with due regard to selectivity.

To improve dependability and security, critical features associated with protection systems and circuit breaker operation should be monitored and annunciated. These features include integrity of power supplies, signal levels, integrity of trip circuits and relay operations.

If required, sequence of event recorders and oscillographs should be provided to permit analysis of protection system performance during network disturbances.

EW-1.16.3 Relay-Setting

Recommended relay settings shall be issued by the Contractor after being supplied with needed basic data from the NPC.

EW-1.16.4 Inter-Tripping

Breakers in adjacent stations have to be opened when the breaker fails to isolate a primary fault. This tripping of breakers in adjacent stations shall be achieved by direct inter-tripping activated from the breaker failure protection.

EW-1.16.5 Relay Indications

All relay protection shall be provided with resettable visual indicating devices for trip functions in the individual protective relay or group of relays for all protection belonging to a primary object. These indications shall be clearly visible without the need for opening doors, or the like, on the relay cubicles or other enclosures. Indication devices shall be provided for every relay protection. Start indications from time delayed protective relays are required. The faulty phases shall be indicated when the measuring principle in the protection makes this possible. Multi-stage protection shall be designed so that the indications will clearly show the stage which has initiated tripping. Tripping indication shall always be provided, regardless of the duration of the tripping signal.

The following colors shall be made available for visual indications:

- yellow : start indication
- red : trip indication
- green : auxiliary power

In addition to the above visual tripping indications, corresponding potential-free contacts shall be available for Sequence of Events (SOE) and alarm panel, and these contacts shall close when visual indication is obtained.

EW-1.16.6 Tripping Circuit

The tripping circuit for the relay protection belonging to relay set 1 and 2 shall be separated both electrically and mechanically. This implies that they must not include common switching devices, connectors, terminal blocks, cables, auxiliary relays, etc. Breakers shall have electrically and mechanically separate tripping coils for relay set 1 and 2. The function must not be jeopardized if both coils receive a trip impulse simultaneously, or if one coil is short-circuited.

The design in relay set 1 and 2 shall conform with the following stipulations:

- High functional security and speed are necessary in the tripping circuit, and the system design shall thus be such that a minimum of series-coupled elements will be required.

- The tripping circuits shall be supervised both when the breaker is open and closed. The supervision shall include the d.c. supply, tripping coil, cables (d.c. supply cable and tripping cable to the breaker). The auxiliary contact for the coil shall also be included in the supervision when the circuit breaker is closed. The alarm shall be time-delayed to prevent it operating during momentary dips in the d.c. supply. The alarm shall also be inhibited when the circuit breaker auxiliary switch interrupts the trip coil circuit, on circuit breaker opening.

- Each protection dedicated to one unique object shall have its own tripping equipment. Furthermore, each breaker shall have its own tripping circuit for those protection that are common for more than one object, i.e. Breaker Failure Protection.

- There shall be separate equipment for set 1 and set 2.

- The tripping equipment shall have auxiliary relays, which must have an operating time not in excess of 5 ms. These tripping relays shall also be capable of breaking the circuit to the solenoid, even if the auxiliary contact in the breaker should fail to open.

- Trip relays must be immune to operation with wiring capacitive discharge currents in the event of a DC system earth fault.

- Specified lockout relays shall be of mechanically latched type with manual reset.

- The d.c. circuit used to actuate the tripping relays shall be separate from the d.c. circuit for the tripping coils.

EW-1.16.7 Auxiliary Relays

General

Auxiliary relays shall be vibration proof and shock-proof. They shall be rated for operation at 125 V dc unless otherwise noted. Both the moving and stationary contacts shall be of silver plated. Each one will close and carry 5 A continuously, or will carry 30 A for one minute.

Manual Reset Auxiliary Relay

Manual reset auxiliary relay shall be electrically and manually reset, high speed, multi-contact type. The voltage rating of the relay coil shall be such that, with the suitable series cut-off contact furnished, the operating time shall be approximately one cycle. The relays shall have interlocking contacts in the closing circuit of circuit breakers they operate.

Self-Reset Auxiliary Relay

Self-reset auxiliary relays shall have a dc operating coils corresponding to the DC source specified in the Technical Data Sheets of the equipment and at least three (3) electrically independent, potential-free, normally open contacts.

They shall be suitable for continuous duty and shall have an operating time of about two (2) cycles. The Contractor shall provide at least two (2) spare "a" and/or "b" contacts.

EW-1.16.8 Operating and Service Conditions

The protective and auxiliary relays shall be installed and operated under the following conditions and ratings unless otherwise indicated in the Technical Data Sheets of each protective relay equipment:

Momentary current	:	40 times rated current coil (2 sec)current (5A)
Continuous voltage	:	1.2 times of rated potential coil voltage (115V)
Continuous current	:	2.0 times of rated current coil current (5A)
Make and carry ratings	:	30 amperes for tripping contacts for at least 2000 operation in a prescribed duty (ANSI C37.90-1978)
Insulation	:	2 kV, 60 Hz for 1-minute
Surge withstand capability	:	ANSI C37.90/IEC 60255
Rated frequency	:	60 Hz
1 MHz burst disturbance	:	IEC Publication 60255-22-1 with severity Class III
Electrostatic discharge	:	IEC Publication 60255-22-2 with severity Class III
Radiated electromagnetic field disturbance	:	IEC Publication 60255-22-3 with severity Class III

The test shall be carried out by using Test Method A and by sweeping through the entire frequency range 27 MHz to 500 MHz

Fast Transient disturbance : IEC Publication 60255-22-4 with severity level IV

The Contractor shall also guarantee that all equipment furnished under the scope of this specification shall meet the performance and rating requirements of this specification while operating within the environmental conditions specified in the Technical Data Sheets.

EW-1.16.9 Enclosure and Environmental Requirements

The protective relays shall be enclosed in a free-standing control cubicle with a front hinged-frame suitable for easy installation of functional units, designed for front access.

The installation dimensions for rack mounted equipment should conform to the 19-inch standard.

The enclosure shall be designed to have proper ventilation preventing the occurrence over-heating. The ventilation shall be such that rodents and insects' entry inside the panel are prevented.

The degree of protection of relay cases or cubicles shall be minimum IP50. Relays shall be tropicalized and shall have enhanced corrosion protection.

The enclosure should be provided with a key-lockable full transparent hard plastic protective door mounted on the front of the hinged frame. Equivalent means to protect the individual relays can be provided.

The enclosure shall be provided with enough space for mounting other ancillary equipment as specified. Unused spaces shall be covered with plates. The rear of the cubicle shall be closed suitable for back-to-back or back to wall mounting. The inside rear plane shall be provided with a fixed mounting plane for terminal blocks and other accessories.

EW-1.16.10 Panel/Cubicle Wiring

Wires shall be 600V, stranded copper conductor with thermo plastic insulation and shall comply with the requirements of ICEA Standard No. S-61-402. Minimum size shall be 2.0sq.mm. or larger for control circuit except annunciator wire which shall be 1.2sq. mm. or larger. Minimum test voltage shall be 2000V.

All cubicle wiring shall be neatly run and securely fixed in such a manner that, wherever practicable wiring can be easily checked against diagrams.

The wiring between sub-components of a single systems hall be of adequate dimensions. Point to point wiring to fixed terminals shall be used for CT and trip circuits, however, other circuits maybe plug and socket assemblies of adequate design. Wires shall not be spliced or joined between terminal points.

Soldered or wire wrapped connections shall only be inside electronic systems. Any wire wrapping shall be in accordance with IEC Publication 60352.

Where provisions are made for the addition of equipment not required initially, means shall be provided for supporting and terminating wiring during the interim period.

All panel wires shall be identified at both ends with numbered ferrules according to the wiring diagrams. On rack mounted equipment using wrap or soldered connections within the rack and for all telecommunication circuits, color coded details wiring will be acceptable. Include color code details in drawings, where used. Numbered ferrules shall be fitted to all multi-core cable tails.

Ferrules shall be of insulating materials with glossy finish to prevent adhesion of dirt. They shall not be affected by moisture or oil and shall be clearly and permanently marked. Temporary marking shall not be used.

All power circuits, control and protection wiring and low-level signal wiring shall be physically separated. Separate raceways shall be provided for power cables and the working voltage of each power circuit shall be marked on the associated terminal boards.

As far as reasonably possible, all outgoing wiring should be grouped by function (CT, VT, Trip, Alarm, etc.) with those going to a common destination allocated to adjacent terminal blocks. Terminal block configuration shall be submitted for approval. Labels shall be provided on the fixed portion of the terminal boards showing the function of the group.

Connections for indicating instruments and for the telecommunication circuits from transducers or modem outputs shall use individually shielded wire pairs. One (1) extra terminal per pair of terminals, shall be provided to connect this shield to ground.

If wiring is provided between swinging panels, bundled conductors shall be used on the hinged doors or panels with extra/flexible wire, so arranged that a twisting rather than a bending motion, is imparted to the moving bundled conductors. Each bundle shall be anchored such that the moving bundled length is the maximum available without loops.

Wiring shall be arranged to give easy access to the terminal or relays and other apparatus.

EW-1.16.11 Cubicle Construction

The cubicle shall be of the type specified in Technical Data Sheets of the individual protection equipment. It shall be of reliable construction, of rugged design and modularized.

The cubicle shall be made of smooth sheet steel panels with angle or channel frame and with edges bent to 6.0 mm radius, seam-welded at corners and ground smooth. The panels shall be bolted at the bottom to suitable steel

channel sills to be furnished as part of this supply. Suitable grounding and anchor bolt holes shall be provided in the channel sills. Butt joints on outside surfaces shall not be permitted. Outside panels shall not be drilled or welded for attaching wires, resistors or other devices where such holes or fastening will be visible from the front of the panel. All screws and bolts used for assembling members and panels and for mounting wire cleats and devices shall be provided with lock washers or other locking devices. Vertical edges of panels shall be formed and bolted together in such a manner that no part of edges are exposed to view. The panels shall not deviate more than 1.6 mm from the true plane. To prevent warping of panels, all heavy devices shall be adequately supported by means of rear mounted brackets or straps.

The cubicles shall be constructed from a minimum of 2.0 mm sheet steel with edges formed into a rectangular pattern or welded to steel shapes so that each section is rigid and self-supporting and enclosed.

The panels, trim, doors and frames shall match and shall present a neat appearance when assembled. Electrical clearance shall be provided without cutting away the adjacent steel framework. Vents or louvers shall be provided, where required, to give adequate ventilation. All ventilation openings and all opening in the floor shall be provided with screens to prevent entrance of insects and rodents. Thermostatically controlled heaters with switches shall be furnished for prevention of condensation. Heaters shall be suitable for auxiliary power supply specified in the Technical Data Sheets of the telecommunication equipment.

The design of the cubicle and arrangement of devices shall be such that adequate space is provided for inspection and maintenance of wiring, terminals and equipment. Equipment inside the panels shall be so mounted that the studs of the equipment mounted on the panels will be accessible without removing any device. American Standard device number shall be used and marked on the rear of the panels near the corresponding device. The device numbers shall be marked legibly with permanent marking fluid that will form a contrast with the panel finish.

The dimensions of a cubicle shall be as follows unless otherwise specified in bid drawings and/or the Technical Data Sheets:

a.	Depth	700 mm (maximum)
b.	Width	750 mm (maximum)
c.	Height	2200 mm (maximum)

EW-1.16.12 Facilities for Relay Testing and Maintenance

The design of the protection system shall allow easy maintenance of its functions. It shall be possible to check the operating levels and each of the functions separately. The whole functional unit shall also be able to be tested. All tests shall be performed from the front panel. Provisions for push button functional test of the relay shall also be preferably available.

An independent test facility for each individual protective relay, although several relays may be connected together in a common cubicle, shall be

provided. While one relay is being tested the other relays shall remain in operation.

The test facilities shall include a permanently mounted test block and shall be paired with a test plug. Switching and isolation of inputs/outputs by means of electrically-operated auxiliary relays is not acceptable. The test facilities may be supplemented by a manually-operated switch, if necessary to comply with all provisions stated below. Details of the test facilities shall be submitted for approval before being used.

The following shall be accomplished automatically and in a safe sequence, to prevent spurious tripping and ensure safety of personnel, when the test position is selected or when the test plug is inserted into the test block:

a. Isolate the tripping circuits, teleprotection signaling circuits, breaker fail and other circuits which could affect the tripping functions.
b. Isolate the relay under test from the CT circuit while maintaining the CT through connection to other relays or instruments in the series-connected chain without opening the circuit at any instant. This process shall not require the test technician to connect external shorting wires before inserting the plug.
c. Isolate the relay from the VT circuit
d. Isolate DC auxiliary supply (optional)

A separate single-finger test plug which can be inserted into the test block, to connect a test instrument, to allow measurement of current or voltage magnitudes and phase angles shall also be provided.

The test plug shall be designed to provide protection to personnel should an open-circuit develop on the external circuit to the test instrument, by shorting the test finger when the voltage across the open CT circuit exceeds a dangerous level not more than 200V.

Means of allowing secondary injection of test currents and voltages using standard 4-mm banana plugs should be provided on the test facilities.

Provide monitoring points on the test block/plug to monitor status of test points such as relay starts, phase selection, trips for each phase, and other critical functions by means of contacts to be connected to the test equipment.

Provide, for each cubicle, a set of test cables with a length of at least 2.5m, to connect the relay under test to the test equipment. It shall include all the wires to monitor all the circuits and inject currents and voltages.

Provide diagnostic and extender cards as well as suitable test probes to match internal test points of the relays to facilitate testing and trouble-shooting.

It shall also be possible to close the cubicle door, even when a block plug is used for disabling operation or tripping of the relay.

EW-1.16.13 Current Circuit

The relay protection shall be designed for a rated current, which corresponds to the secondary rated current of the current transformers. The relay protection shall be dimensioned on current transformers with data in accordance with the apparatus specifications in this document.

The current circuit shall be earthed in the junction box nearest the current transformer in the switchgear. In the case of summation of currents by direct galvanic connection, the circuit may only be earthed at one point and in the junction box nearest the current transformers.

In the first junction box in the substation yard, provisions shall be made for short-circuiting the current circuit in a simple manner. This can be arranged with a suitable design of the terminal block.

Separate current transformer cores shall be used for relay set 1 and 2.

EW-1.16.14 Voltage Circuit

The relay protection shall be dimensioned on the basis of capacitive voltage transformers with data in accordance with the apparatus specification in this document.

The secondary windings of the voltage transformers in the various phases shall be interconnected and earthed in the junction box nearest the voltage transformers. The interconnecting and earthing shall be carried out in such a manner that a correct reflection of the primary voltage will be obtained. No earthing, in addition to the above, may be employed in the galvanic connection parts of the voltage circuits.

The voltage circuit shall be divided into separate groups for relay set 1 and 2. A group for the protective relays must not be used for any other purpose. All subdivisions into groups shall be carried out in the junction box nearest the voltage transformer, where the various groups shall also be individually protected against short circuits with miniature circuit breakers.

The following general functional requirements shall be fulfilled:

For Miniature circuit breakers:

The miniature circuit breakers shall be placed in the junction box nearest the CVT.

The miniature circuit breaker shall be provided with electromagnetic and thermal protection elements.

The miniature circuit breaker shall have potential free contacts for blocking purpose and signaling.

EW-1.16.15 Relay Panel Accessories

Terminal Blocks

Terminal blocks shall be mounted so as to give easy access to wires terminations and ferrules and shall give a clear view of the arrangement of cable tails. The AC, DC current and voltage transformer inputs shall be separately grouped and adequately protected. Each wire shall be connected to an individual terminal which shall have a clearly lettered marking strip corresponding to the wiring diagram. To allow for extensions and alterations, approximately 25% extra terminals should be provided per terminal block.

Terminal blocks for control wiring shall be rated not less than 30A, 600V with barriers of the type approved by the NPC.

Isolation-type terminal blocks shall be provided for the auto-reclosing scheme isolation for all external alarms on each panel. Isolation-type terminal blocks for the sequence of events and transient fault recorder terminals shall also be provided. Shorting type of terminal blocks for current circuit isolation to transient fault recorder shall be provided.

Terminal blocks shall not have more than twelve positions per block, shall be rated 600 volts, 30 amperes, shall be one-piece type and shall have vinyl marking strips. They shall have terminal screws on both sides; box clamps or saddle clamp terminals are not acceptable. No live metal shall be exposed at the back of the terminal blocks.

Every terminal point shall have individual and complete identification identical to those on the wiring diagrams and shall be acceptable to NPC. Terminals for NPC's external connections shall be arranged for consecutive connections of conductors within one cable. Only one external wire will be connected to each outgoing terminal point. Wires (usually three to five, including ground isolating jumpers) for a given current transformer or voltage transformer circuit shall be connected to a single terminal block; they shall not split between two blocks.

Nameplates

Each piece of equipment mounted on or inside the panels shall be provided with a nameplate. Nameplate shall be made or laminated black surface, white core micarta or sheet plastic with lettering engraved on the black surface exposing the white core. Single phase items shall be identified by nameplates as to the particular phase in which they are connected. Nameplate size shall be approximately 25 by 75 mm or 50 by 150 mm. The nameplates shall be fastened to the panels with black finished round-head screws. Nameplate design shall be submitted for approval to the NPC, together with samples of engraved nameplates.

Ground Bus

A ground bus of copper bar not less than 60 sq. mm. shall be bolted to the frame of each of the panel in such a way as to make a good electrical contact. For the relay panels, a ground bus shall be provided along the front of the

panel and shall be connected at each panel end to the next panel in the lineup.

The ground bus shall have drilling at each end to permit interconnections with the ground buses in adjacent units. The necessary copper bar jumpers, bolts, nuts and washers for making interconnection shall be furnished.

The ground buses in the relay panes at the left and right ends of the lineup shall be provided with a solder bus clamp type pressure connector for terminating 60 mm^2 of stranded copper ground conductor.

Interior Lighting and Convenience Outlets

A switch controlled fluorescent lamp shall be installed at the top of each panel for internal illumination. The switch shall be located at a convenient height inside the unit. A duplex convenience outlet with a rating specified in the Technical Data Sheets of the equipment shall be furnished and installed in each panel at a convenient location.

The lamp switch and convenience outlet shall be located near the latch side of the door in single door panels and near the hinge side of a door in double door units. The lamp and convenience outlet shall be wired to terminal block points for connection to a power source specified in the Technical Data Sheets for the equipment.

EW-1.17 MISCELLANEOUS

EW-1.17.1 Communication

For each Local Control Panel in the switchyard (control cubicle of circuit breaker, transformer control cubicle, BCU building (if BCU is required outside of the Control Room) and marshalling kiosk), a telephone connection to the Control Room shall be provided to enable reliable communication with a mobile telephone set at any time.

EW-1.17.2 Provisions for Erection and Installation

All parts of the equipment to be assembled on site must be connected by means of screws and bolts/nuts, welding is not acceptable except for accessories and where expressly stated.

It must be possible, except in particular cases, to introduce and draw out all the indoor equipment through the doors or opposite opening.

EW-2.0 POWER TRANSFORMER

EW-2.1 SCOPE

EW-2.1.1 General

This specification covers the technical and associated requirements for power transformers and accessories for use in electric generating station and/or substation. The requirements of the project and the equipment details are indicated in the Technical Data Sheets.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. The Contractor shall furnish high quality power transformers meeting the requirements of these specification and industry standards.

The Contractor shall bear full responsibility that the equipment has been designed and fabricated in accordance with all codes, standards, and applicable governmental regulations and performs under the conditions and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exceptions, these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exemptions are taken to this specification.

EW-2.1.2 Works to be Provided by the Contractor

The Contractor shall provide the equipment, accessories and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-2.1.3 Works to be Provided by NPC

NPC shall provide the materials and services listed in Section B.1.0 of the Technical Data Sheets.

EW-2.2 CODES AND STANDARDS

EW-2.2.1 General

The equipment furnished shall be in accordance with, but not limited to, the latest issues of the following codes and standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification:

ANSI/IEEE	**American National Standards Institute and/or Institute of Electrical & Electronic Engineers**
B1.1. a	Metric Translation, Optional Supplement to Unified Screw Threads
B2.1	Pipe Threads (Except Dryseal)

B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
B16.10	Face-to-face and End-to-End Dimensions of Ferrous Valves
B57.1	Compressed Gas Cylinder Valve Outlet and Inlet Connections
C57.12.00	General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
C57.12.10	Requirements for Transformers, 230,000 volts and below; 833/958 through 8,333/10,417 kVA, single-phase, 750/862. Through 60,000/80,000/100,000 kVA, three-phase.
C57.19.00	Standard General Requirements and Test Procedure for Outdoor Power Apparatus Bushings
C57.19.01	Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
C57.19.101	Trial-Use Guide for Loading Power Apparatus Bushings
C57.12.70	Terminal Markings and Connections for Distribution and Power Transformers
C57.12.80	Terminology (IEC76), including Supplement C57.12.80a.
C57.12.90	Test Code for Distribution, Power and Regulating Transformers, including Supplement C57.12.90a.
C57.13	Standard Requirements for Instrument Transformers.
C57.92	Guide for Loading Oil-Immersed Distribution and Power Transformers
C57.98	Guide for Transformer Impulse Tests
C57.106	Guide for Acceptance and Maintenance of Insulating Oil in Equipment
C57.109	Guide for Transformer Through-Fault-Current Duration
C57.110	Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents
C57.115	(redesignation of IEEE Std 756, Trial Use May 1984), Guide for Loading Material-Oil Immersed Power Transformers Rated in Excess of 100 MVA (65^0C Winding Rise)
C62.11	Guide for Metal Oxide Surge Arresters for Alternating-Current Power Circuits
C80.1	Specification for Rigid Steel Conduit, Zinc Coated
Z55.1	Gray Finishes for Industrial Apparatus and Equipment (No. 24 Dark Gray and No. 61 Light Gray)
IEEE Std.80	Guide for Safety in AC Substation Grounding
IEEE Std. 979	Guide for Substation Fire Protection
IEEE Std. 980	Guide for Containment and Control of Oil Spills in Substations

ASTM	**American Society for Testing and Materials**
A344	Electrical and Mechanical Properties of Magnetic Materials
A153	Zinc coating (hot dip) on iron and steel hardware
B432	Copper and Copper Alloy Clad Steel Plate
NEMA	**National Electrical Manufacturers Association**
107	Methods of Measurement of Radio Influence Voltage of High-Voltage Apparatus

ICS	**General Standards for Industrial Control and Systems**
MG-1	Motors and Generators
MG-2	Safety Standard for Construction & Guide for Selection, Installation and Use of Electric Motors and Generators
SSPC	**Steel Structure Painting Council**
SP1	Solvent Cleaning
SP3	Power Tool Cleaning
PA1	Shop, Filed and Maintenance Painting
PA2	Measurement of Dry Paint Thickness with Magnetic Gages
UL	**Underwriters Laboratories, Inc. (all parts apply)**
44	Rubber-Insulated Wires and Cables
IEC	**International Electro-Technical Commission**
60044	Instrument Transformer
60071	Insulation Coordination
60076	Power Transformers, Parts 1-5
60060	High Voltage Test Technique
60137	Bushings for Alternating Voltages Above 1000V
60214	On-Load Tap Changer
60270	Partial Discharge Measurements
60296	Specification for unused mineral insulating oil for transformer and switchgear
60354	Loading Guide for Oil-immersed Power Transformers
60542	Application guide for on-load tap-changers
60551	Determination of Transformer and Reactor Sound Levels
60599	Interpretation of the analysis of gases in transformers and other oil-filled electrical equipment in service
60606	Application guide for Power Transformers
60616	Terminals and tapping markings for power transformers
60722	Guide to the lightning and switching impulse testings of power transformers and reactors
60947	Low Voltage Switchgear and Control Gear
NFPA	**National Fire Protection Association**
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation & Servicing

These codes and standards set forth the minimum requirements which may be exceeded by the Contractor, if, in the Contractor's judgment and with NPC's acceptance, superior or more economical designs or materials are available for successful and continuous operation of the Contractor's equipment as required by this specification.

EW-2.3 TECHNICAL REQUIREMENTS

EW-2.3.1 Description of Services

The power transformer(s) covered by this specification is (are) for use in a generating station and/or a substation. The application details are stated in the Technical Data Sheets.

Depending on the requirement stated in the Technical Data Sheets, the transformer shall be provided either with an automatic fire detection and extinguishing system (Deluge System) according to NFPA requirements to extinguish accidental transformer fire and to prevent occurrence of fire on the adjacent transformer in case of fire from the other, or an equivalent Transformer Explosion and Fire Prevention System utilizing nitrogen gas as a preventive measure in avoiding transformer explosion and ensuring non-occurrence of fire on the transformer and the adjacent equipment.

The transformer shall be designed and provided with an oil collection pit for oil containment according to NFPA requirements. The oil collection pits of all transformers shall be connected to an oil separation pit.

Fire wall shall also be provided between transformers, between transformer and structures and/or other inflammable equipment if the clearance is less than what is shown below:

Transformer Capacity (MVA)	Clearance (m)
above 1 up to 10	below 3
above 10 up to 40	below 5
above 40 up to 200	below 10
Above 200	below 15

EW-2.3.2 Design Requirements

EW-2.3.2.1 Ratings

Transformer rating, specified in the Technical Data Sheets shall be the basis of the Contractor's guarantee as to performance and temperature rise. The ratings indicated are based on actual load requirements at the service and operating conditions specified herein.

EW-2.3.2.2 Voltage

Unit auxiliary transformers and generator step-up transformer shall be designed to withstand the overvoltages for the duration of voltage excursions which may be expected as a result of full load rejection of the generator.

The unit auxiliary transformer shall be able to withstand the short circuit resulting from a secondary external fault on the unit transformer which is accompanied by a rise in generator voltage as specified in the Technical Data Sheets.

EW-2.3.2.3 Frequency

Frequency for operation shall be 60 Hertz.

EW-2.3.2.4 Overload Requirement

The overload rating and operation shall be in accordance with all cyclic loading duties as specified in IEC 60354. The overload capability of any auxiliary equipment such as bushings, LTC's, CT's, oil expansion tanks, leads, etc. shall not be less than the transformer overload rating. If other considerations will limit the overload capability of the transformer, the Contractor shall specify these limitations in his proposal.

EW-2.3.2.5 Short Circuit Capability

The transformer, including its accessories such as, but not limited to, bushings, current transformers, tap changers, etc., shall be capable of withstanding the specified short circuit requirements without mechanical deformation or impairing the electrical capabilities.

The thermal and mechanical capability of the transformer and its accessories shall meet or exceed the requirements listed in ANSI C57.12.00, Section 7 or IEC 60076.

The above for unit auxiliary transformers and generator step-up transformers is appended as follows:

a. These transformers shall have increased mechanical and thermal capabilities to withstand three-phase short circuits external to the transformer with the maximum voltage as the driving voltage during the voltage excursions.

For transformer connection of wye-wye-delta or wye/wye-delta, the fault current produced by the short circuit shall be considered to be coming from both HV and LV sides.

The system impedance shall be obtained from the system fault capacity as specified in the Technical Data Sheets. The duration of the short circuit is limited to 2 seconds.

The transformer shall be so designed that the final winding temperature T_f reached at the end of the specified short circuit duration shall not exceed 250^{0}C for aluminum conductors or another temperature stipulated by the Contractor without annealing the conductor, without causing insulation damage and gas generation from oil or solid insulation. It shall be assumed that prior to and after the short circuit, the transformer is loaded at its maximum nameplate rating and the ambient temperature is the specified maximum.

The sudden pressure relay and other alarm initiating devices shall not respond to the effects of the through fault short circuit currents.

EW-2.3.2.6 Impedances

Impedance between winding will generally vary with changes of transformer turns ratio. Limitations on this change of impedance shall apply to all fully-rated taps on all main power windings, but not to auto-transformers. These limitations are, in part, defined in terms of the tested impedance on the fully-rated tap nearest the middle of the fully-rated tap range. This impedance is called the mid-tap impedance.

a. The percent deviation of impedance on the extreme taps shall not be greater than the mid to extreme tap voltage range expressed as a percentage of rated voltage and the lowest impedance value shall be related to the highest current tap.

EW-2.3.2.7 Audible Sound Level

The average sound power level LpA of the transformer shall not exceed the values as specified in the Technical Data Sheets when measured in accordance with the conditions outlined in the latest ANSI/IEEE C57.12.90 or IEC 60551.

EW-2.3.2.8 Transformer Loss Evaluation

The Contractor is required to fill- in all the information for the transformer losses in the Technical Data Sheets in order for the NPC to fully determine the most cost effective of the proposed transformer(s) to be supplied considering both cost of losses and first cost.

Failure of the Contractor to completely fill- in all the information needed for proper evaluation by the NPC shall be a ground for rejection of his bid.

In considering the capitalized cost of transformer losses, and for purposes of comparing bids, the losses will be evaluated using the values ($/kW loss) specified in the Technical Data Sheets. In the bid evaluation procedure, each loss evaluation figure listed in the Technical Data Sheets will be multiplied by its respective guaranteed loss value in kilowatts, and the resulting figures will be added to the bid price to give a total evaluated price for bid comparison.

The transformer shall be designed for the most economical loss ratio (copper loss/iron loss) for the application as specified in the Technical Data Sheets for the transformer.

EW-2.3.2.9 Tolerances

Values from tests shall meet those specified in the Technical Data Sheets within tolerances stated in standards supplemented as follows:

a. Losses: Core loss after impulse tests shall be the value used in determining performance and shall not exceed the core loss before impulse test by more than 7-1/2 percent.

b. Exciting Current: The percent tolerances from specified values for exciting current shall be the same as those stated in the standards for

no-load losses. If the value of the exciting current increase, after impulse tests by an amount 10 percent or more of its value before impulse tests, without an associated increase in core loss, the Contractor shall notify NPC and shall conduct such tests and examination as may be required to assure NPC that a turn-to-turn fault does not exist in the transformer winding.

c. Impedance: When parallel operation with other units is specified in the Technical Data Sheets for the transformer, impedance tolerances stated in standards shall apply to the tap voltages of like turns ratio, in addition to that of the rated voltage.

EW-2.3.2.10 Bushings

All porcelains used in bushing shall be wet process, homogenous, and free from cavities or other flaws. The glazing shall be uniform in color and free from blisters, burrs and other defects. All porcelain parts shall be one piece.

The bushings of the same rating shall be interchangeable.

Bushing up to 110 kV BIL shall be porcelain bulk type whereas bushings above 110 kV BIL shall be condenser-type. In the latter case, the bushing shall be provided with capacitance test tap.

Should compound filled condenser type bushings be adopted, provisions shall be made to avoid compound entering the main tank during vacuum treatment.

Bushings shall have the continuous current-carrying capacity necessary to carry the full 65^0C rise current. The bushings shall also be capable of carrying overload currents as required by section EW-2.3.2.4.

Bushings shall be in accordance with ANSI C57.19.01 & 101 or IEC 60137. Strike distance in excess of those to meet the standard will be specified in the Technical Data Sheets for the transformer. (Extra strike distance may be required to accommodate multiple conductor connections, grading rings, heavy buswork, future external CT and isolated phase bus connections).

EW-2.3.2.11 External Clearances

External clearances between energized parts and ground, and spacing between adjacent phases shall be coordinated with the transformer internal insulation class. However, when coordination is required with higher insulation levels of other associated substation facilities, the clearance requirements will be specified in the Technical Data Sheets for the transformer.

EW-2.3.2.12 Oil

This technical specification applies for the condition of transformer oil at delivery. The oil shall be of such a quality that it is, suitable as an insulant and coolant for transformers.

The oil shall be new and naphthenic based mineral oil. It shall be free from Polychlorinated Biphenyl (PCB), moisture, acid alkali and sulfur compounds and shall not form a deposit at normal operating temperature.

Except for inhibitors, no additives are permitted.

The oil furnished shall be compatible with other oils meeting the requirements of ASTM D3487 and this specification. The oil shall be suitable for mixing with other insulating oils in any combination and the mixture shall still meet the required functional properties of this specification. Any reservation to this requirement shall be clearly stated by the Contractor in his proposal.

The oil shall accept 2, 6-ditertiary-butyl-paracresol (DBPC) as an oxidation inhibitor, added as necessary to bring inhibitor content of the oil to the required ASTM D3487, Type I or II value. The Contractor shall state if any other type of oxidation inhibitor is acceptable and if so, its advantages over DBPC.

The supply of insulating oil per transformer shall include a sufficient quantity to fill the tank and radiators up to the operating level plus an excess of 5%.

The power factor of the oil shall not exceed 0.05 percent at 25^0C or 0.3 percent at 100^0C, as determined by ASTM Test Method D924 (oil samples shall be taken in accordance with ASTM D923).

The oil flow pattern shall exclude turbulence and impinging of oil on any part of the solid insulation system.

Containers for oil shall be so designed that, with the indicated level for initial filling at 25^OC, the oil will not fall below a safe operating level, nor rise to such a height as to overflow or leak. Design shall be for a standard top oil temperature range or greater, if required by the upper and lower limits of ambient temperature specified in Section B.1.0 of the Technical Data Sheets.

If the transformer oil will be delivered in containers or drums, these shall be approved by the NPC. The containers and/or drums shall be well-cleaned internally and shall otherwise be in such a condition that there is no risk of endangering the oil quality.

Before delivery, a test certificate shall be submitted to the NPC for approval. The test certificate shall contain result for tests carried out in order to confirm the oil's quality as specified.

EW-2.3.2.13 Auxiliary Power and Control

Unless specified otherwise in the Technical Data Sheets for the transformer, the Contractor shall provide two full capacity, independent 460 - 480 volt, 3 phase, 4-wire power supplies for the transformer for its cooling and power requirements and one 125 volts dc supply for the annunciator and any other control requirements. For termination facility, see Section EW-2.3.3.9. The cooling devices shall be grouped into as many partial capacity groups as there are power supplies provided. Each group shall be supplied from its own power supply during normal conditions. If one supply fails it should be

transferred automatically to the remaining power supply. Automatic transfer equipment shall include a time delay relay to prevent immediate transfer from normal to emergency source.

Contractor shall furnish any step-down transformers required for power supply requirements other than stated above.

A separate circuit breaker shall be furnished to supply 230 voltage ac power to all transformer space heaters as well as one 20-watt fluorescent lamp and one duplex convenience outlet 15A, 250V, 2-poles in the main control cabinet.

Air circuit breakers shall act as circuit protective devices for all circuits. For feeders, the breaker shall afford both overcurrent and short circuit protection to the conductor.

Circuit breakers shall be manually operated, trip-free, fitted with thermal-magnetic trip elements, auxiliary contacts and shall have the specified interrupting capacity.

DC coils, lamps and other devices shall be designed to withstand the battery equalizing voltage (112%) of battery voltage) continuously without malfunctioning.

All circuit breakers shall comply with IEC 60947-2.

EW-2.3.2.14 Use of Inert Gas

Each core and coil unit shall be shipped in an atmosphere of inert gas to prevent moisture absorption. The core and coil shall be shipped as a unit in their tank.

EW-2.3.3 Design and Construction Features

EW-2.3.3.1 General

All transformers of the same design and rating, furnished on a given order, shall be electrical duplicates, shall have mechanically interchangeable parts and shall be operable in parallel.

Construction of transformer shall provide for successful transportation so that on arrival at destination, transformers shall be in condition for immediate permanent operation after having installed all the accessories and coolant have been added, if required.

Transformer and accessory design, manufacture and assembly shall minimize vibration and shall prevent damage by inherent vibration and stress during operation, transportation and short circuits. If a flood level is specified in Section B.1.0 of the Technical Data Sheets, no device, control cabinet, fan, etc. should be located below that level.

Wheels, if specified in the Technical Data Sheets for the transformer to facilitate transformer movement, shall be rust and corrosion resistant and shall be lubricated for the lifetime of the transformer.

The assembled transformer including its accessories shall withstand the wind forces specified in Section B.1.0 of the Technical Data Sheets.

Current carrying joints and splices shall be welded, brazed or made by compression fittings so that the contact resistance remains unchanged during the life of the transformer. Soldered connections shall not be used.

All leads not brought directly to bushing terminals or tap changers shall be brought to terminal boards, constructed over insulating material, and substantially and rigidly supported inside of case.

All terminal boards of liquid filled transformers shall have live parts submerged under the liquid and so located that any reconnections can conveniently be made from handhole or manhole with removal of a minimum quantity of liquid. Where compliance with this requirement is impractical due to large clearance and creepage distance necessary with high voltages, the Contractor shall so state in his proposal. There shall be a minimum of detachable fittings and other parts which might come loose and lodge in transformer windings.

The core shall be grounded to the tank cover at one point only through removable links in an appropriate terminal box, placed in an accessible position on the tank cover and which, by disconnection, will enable the insulation between the core and transformer tank, etc., to be tested at voltages up to 2.5. kV for the purpose of checking deterioration during service.

Jacking facilities shall be in accordance with ANSI C57.12.10 with the locations stated in Section EW-2.3.3.6.

EW-2.3.3.2 Cores

Cores for the transformer shall be constructed of the highest quality, non-aging high permeability grain-oriented silicon steel and the magnetic flux density shall not exceed 1.8 Tesla. The steel shall be in thin lamination, annealed after cutting and rolled to insure smooth surface at the edges.

The laminations must be free from impurities and must receive stress relief treatment after punching. The lamination shall be accurately flattened, especially at the edges and insulated by suitable procedures with long-life heat resistant insulating coat.

Both sides of each sheet shall be insulated with a durable heat resistant insulation. The core shall be held firmly by core clamp and braced to ensure adequate mechanical strength to support the winding and to withstand without damage or deformation, the forces caused by short circuit stresses, transportation or handling to prevent shifting of the core laminations.

The core shall be solidly grounded to the tank and shall be provided with approved lifting devices or lifting lugs at suitable points of the core assembly for core lifting.

EW-2.3.3.3 Windings

Windings for the transformer shall be of the best modern design conductor having constant cross-section along the whole windings including those of built-in series reactors, if required particularly for EHV transformer and shall have uniform insulation or graded insulation as required. In case of graded insulation, the AC withstand voltage level for neutral points shall be at least one-third of that as applied for the related line terminals to withstand all AC voltage stresses caused by application of any of the short-time induced AC withstand tests to be performed in accordance with the applicable standard.

All windings and their leads shall be designed and arranged such as to withstand all kinds of transferred over-voltages. Built-in series reactors, if provided, are only permitted to be connected in-line with the leads to the entrances of delta-connected tertiary windings, and they shall be designed and arranged with particular attention to keep all transferred over-voltages as low as possible and to avoid serious resonance. Protective capacitors shall not be provided for any of the windings. Non-linear protective elements in any winding other than the regulation windings are not acceptable.

The design, construction, and treatment of windings shall give proper consideration to all service factors, such as high dielectric and mechanical strength of insulation, coil characteristics, uniform electrostatic flux distribution, prevention of corona formation and minimum restriction to free oil circulation.

Winding conductors shall be free from scale, burrs and splinters and shall be uniformly insulated. Permanent current-carrying joints for splices shall be welded or brazed, properly formed and finished, and insulated to conform to the basic insulation.

The completed winding assembly shall be securely held in place so that there will be no derangement or deformation by stresses incident to shipment.

The completed assembly of core and coils shall be vacuum dried, immediately impregnated and immersed in dry oil. They shall be adequately braced to withstand ocean shipment, short circuit forces and earthquakes with seismic coefficient specified in Section B.1.0 of the Technical Data Sheets. To increase the capability of the transformers of withstanding short-circuits, modern technology in design and construction shall be applied, i.e. by application of a low current density, not exceeding 2.7 A/mm^2 in any part of the windings at rated output, pre-drying and pre-compressing of the windings before mounting onto the core.

The windings shall be designed to permit practically no change or very small change in transformer impedance regardless of tap position.

EW-2.3.3.4 Bushings

Each bushing rated below 2000 amperes shall be provided with a single-tang flat-pad terminal. Terminals rated 600 amperes and below shall have two or four hole pads. All others shall have four hole pads drilled in accordance with NEMA CC-1. The width of two hole pads shall be a minimum of 50 mm (2 in.). The minimum pad thickness shall be 6.25 mm (1/4 in.). Terminal construction shall permit terminal rotation round the bushing stud to facilitate connection to the bus.

The terminal pads shall be of high conductivity bronze or copper and shall be plated with hot-flowed electro silver or electro-tin to a thickness of not less than 0.0127 mm (0.005 in.), or an aluminum alloy with hardness Hb minimum of 750 N/mm^2.

Whenever, a larger terminal pad is required for higher current rating, the mounting holes shall conform to NEMA Standards and details of the mounting holes shall be submitted for approval.

All oil filled bushings shall be leak-proof and equipped with an oil level gage. Oil filled bushing may either be the sealed type or provided with an oil sampling drain valve.

All bushings shall be arranged on the tank top cover in such a manner, that removal of the same is possible without lowering of the oil to such a level where the windings are exposed to the atmosphere. Appropriate bushing turrets shall be provided for all of the bushings. Horizontal bushing arrangement is not permitted.

All bushings shall be designed for storage in a horizontal position without any restriction.

EW-2.3.3.5 Gaskets

Gaskets shall be unaffected by hot insulating oil, retain their resiliency during the life of the associated equipment, and be unaffected by weather while maintaining oil and gas tightness. Nitrile rubber gaskets are acceptable. Gaskets of neoprene and/or any kind of impregnated/bonded cork or cork only are not acceptable. Gasket flanges shall have grooves or metal stops to prevent over compression of gaskets. All bolted transformer tank or accessory openings shall be gasketed.

Hatches in the tank cover and sides, intended to be opened a number of times (e.g. connection and inspection hatches), shall have gaskets which can be reused after opening (rubber type, not glued).

EW-2.3.3.6 Tanks

All seams required in the fabrication of the main tank, including those for the cover, shall be welded. All joints, which may be opened from time to time in the course of operation, shall be designed to be oil-tight in reassembly.

The tank shall be capable of withstanding, without leakage or permanent distortion, an internal gas pressure of 1 kilogram per square centimeter (measured at the top of the tank) and a vacuum of 76 cm of mercury and shall be designed and constructed for vacuum filling in the field.

The transformer tank and its accessories shall be designed without pockets wherein gas may collect. For bushing turrets, etc., pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes shall have minimum inside diameter of 25 mm.

All valves, fittings and pipings shall be designed and constructed for such vacuum filling.

The upperside of the tank shall be designed in such a way as to avoid water deposits on top of the tank.

Covers for manholes and handholes shall be provided with two lifting handles each.

The tank shall be provided with the fabricated or structural steel base designed and built to allow skidding or moving on wheels or rollers. The wheels or rollers, if required in the Technical Data Sheets can be turned at right angle, thereby eliminating the need for a traverser for turning the transformer.

The jacking pads provided for the transformer tank shall be located at least 300 mm above the service level with the open space in front of the attaching plates or pads at least one meter above the service level.

Oil conservator or expansion tanks shall be of rugged design and of sufficient capacity to maintain an oil seal through a standard top oil temperature range or greater, if required by the upper and lower limits of ambient or water temperature specified in the Technical Data Sheets for the transformer. Each such tank shall be equipped with a weatherproof silica gel breather in which only blue silica gel (pink colored when wet) has been filled as a dehydrating agent, an oil level indicator easy to see from the ground level with alarm contact for the low level and with isolating cock and a sump with a drain valve. Pipe connection between main transformer case and conservator or expansion tank shall include a shutoff valve to limit circulation of oil, and shall be arranged with a flanged joint or pipe union connection between main transformer case and shutoff valve. Conservator or expansion tanks shall be mounted so as to permit their removal.

A vacuum application valve and vacuum equalizing valves, one for diaphragm and one for LTC conservator, shall be installed at a convenient floor height between the air expansion pipes to the silica gel breathers.

The pipes connecting the conservator to the main tank shall be provided with:

a. a Buchholz relay with alarm and trip contacts for transformer main conservator which shall be free from operation due to vibration and pump surges (if transformer is provided with forced oil cooling)

b. an adequate isolating valve for each relay on conservator side, easily accessible from tank cover, to permit the removal of each relay

EW-2.3.3.7 Filter Sampling and Drain Connections

Drain filter and sampling valves shall be provided as specified in ANSI C57.12.10, except for the following:

- Any pockets or loops provided for collecting moisture (such as in conservator type transformer), shall be equipped with suitable draw-off valves, located at the lowest points of the pockets or loops.

All drain and oil sampling, filling and filtering valves as well as vacuum application and vacuum equalizing valves shall be mounted at convenient floor height and shall be equipped with rigid padlocking facilities and padlocks provided with master key system separate for each transformer unit.

EW-2.3.3.8 Radiators and Coolers

Self-cooled or forced-cooled transformers shall be equipped with removable radiators or coolers for heat radiation. Clearances shall permit painting and maintenance of tank, tubes, and radiators. Radiators and coolers shall be designed to withstand the same pressures and vacuum as the main tank.

Removable radiators and coolers shall be fastened to transformer case with bolted flange connections. The cooling fins of the radiators shall have a nominal width of not less than 470mm. The nominal sheet steel thickness of the radiator walls shall not be less than 2.0 mm. The radiator fins shall be welded with stiffening rods, horizontally and diagonally, to prevent vibration during operation of the transformers. It is to be considered that the distance between horizontally arranged bracing straps shall not exceed 100 cm and diagonal stiffening rods shall be welded between all of the horizontally arranged bracing straps. Butterfly valves, or other suitable devices shall be provided to permit the ready installation and removal of radiators, and drainage of oil from radiators without drawing oil from the transformer tank. Radiators and coolers shall be equipped with lifting eyes, and so designed that they may be handled without the addition of special bracing. Cooler units shall be of corrosion resistant metals and shall be designed to permit replacement of individual cooler tube groups. Welds shall be smooth to facilitate cleaning.

Forced-cooled transformers shall be provided with at least two completely independent groups of cooling equipment. The forced-cooled ratings should be obtained by the use of single stage fans (Class OA/FA) or two stages fans (Class OA/FA/FA), single stage fans and oil pumps (Class OA/FOA), or two stages fans and oil pumps (Class OA/FOA/FOA or OA/FA/FOA) or any combination thereof as specified in the Technical Data Sheets. However, the number of fans shall not be less than eight (8) fan units.

a. Each cooler pump combination for FOA, FOW, and OA/FOA/FOA types shall be mounted independently of the other and provided with valves on the tank side so that each cooler can be removed or replaced while the transformer remains in service.

b. Cable leads to cooling fans and pumps shall be connected to the power source through weather tight and vibration resistant plugs and connections in such a manner that the leads may be easily removed without shutting down the complete power source.

c. For transformers with two stages of cooling, it should be that the transformer self-cooled "OA" rating be increased by 33.3% and 66.6% respectively with the addition of forced cooling units.

d. The forced cooling system of the transformer shall be designed in such a way that the loss of any two fans, or any fan plus any oil pump, or any oil pump plus any water pump shall not reduce the output of the transformer by more than 20% with temperature rise maintained within specified limits.

Indicating shutoff valves shall be located at the inlet and outlet connections to the transformer and shall be welded directly to the tank. No gasketed joints are allowed between the shutoff valves and the tank.

Valves shall be located between the transformer tank and the pump and between the pump and radiator or cooler to permit pump removal without draining oil from the radiator, cooler or tank. The valves used shall be of a type which offers a minimum restriction of oil flow and shall be provided with an adjustable stuffing gland

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Oil tight blank flanges shall be provided for all valves for use when oil lines are disconnected (e.g. valves at coolers, sample valves, fill valves, etc.).

The fan motors and pump motors shall be totally enclosed, suitable for operation in wind-driven rain. Motor bearings shall be designed for continuous as well as intermittent duty. The bushings and bearings shall withstand end thrust, when required.

Fan and pump motor leads shall be a part of the motor assembly and shall be weatherproof or totally enclosed in flexible weatherproof conduit and shall terminate in a weatherproof, locking type plug and receptacle located near the motors. The motor supply circuits shall then be routed to the cooling equipment control cabinet through rigid galvanized steel conduit.

Design of pumps shall be such that it will preclude any possibility of air infiltration into the insulating oil. Protective measures must also be made to prevent impurities due to pump wear. Simultaneous operation of oil pumps either starting or stopping, shall not cause any misoperation of the fault pressure relay and/or Buchholz relay.

Fans mounted off the horizontal shall be provided with a "rain shield" mounted on the motor shaft where it emerges from the motor housing. Fan blades shall be of SUS 316 stainless steel or aluminum alloy and shall have surfaces designed to keep fan noise to a minimum. Fan blades of any kind of plastics are not acceptable. Mechanical protection against touching of the fan blades shall be provided by galvanized round wire mesh guards on both sides of the fan blades.

The forced-cooling equipment shall include protective and control devices (Section EW-2.3.4.2) assembled in a single control cabinet.

Circuit breakers shall be provided for manual switching of each cooling group. Fuses are not acceptable.

All cooling units shall be identical and interchangeable with one another.

EW-2.3.3.9 Auxiliary Power and Control Wiring

Power and control wiring shall be 600 volts, 2.0 mm. sq. minimum, 7 strand, copper wire with heat, moisture and flame-resistant cross-linked polyethylene insulation or alternate acceptable to NPC. The flame test shall be conducted in accordance with UL 44, Section 85. Where flexibility is required, 19 strand wire shall be used. Wiring shall be free of abrasions and tool marks. All wiring shall be adequately supported to prevent sagging and breakage caused by vibration in transit. Minimum bending radius of the wires shall not be less than 4 times its overall diameter. All wiring shall be brought out to a control terminal cabinet.

Wire shall be of adequate rating for the current to be carried. All current transformer and cooling control circuits shall use nothing smaller than No. 8.0 mm.sq. wire with copper tape shielding and cooling control circuits shall use nothing smaller than 3.5 mm. sq. wire. On other circuits except current transformer secondary circuits were maximum current does not exceed 5 amperes, No. 2.0 mm.sq. wire may be used.

No overheating of the conductor itself or of insulation damage to adjacent conductor shall occur when current transformer secondary conductors carry 100 amperes for one second. For wires associated with dc and ac control circuits, the short circuit current value is 5000 amperes and 5000 amperes rms symmetrical, respectively, and the time interval is 0.016 seconds.

Wiring shall not be affected by transformer oil or its fumes.

Separate terminal blocks shall be provided for power and control wiring with metal barriers in both fixed and removable sections to separate the two wiring classes. They shall be rated not less than 25 amperes, 600 volts. Each terminal block shall be provided with barriers, marking strips and terminal screws. Each terminal point shall be marked with the designation shown on Contractor's wiring diagrams. Each terminal block, for external cable, shall have 12 points and 2 points out of these twelve shall be spares for NPC's future used. Terminal blocks shall be located so that they are accessible and in full view.

The Contractor's wiring shall be terminated on terminal blocks or on equipment terminals with insulated terminals. Spade or intended spade-type terminals with insulation grip shall be used. Ring-type terminals of approved type will also be acceptable. Splicing of wires is not acceptable.

No solder or "push-on" or "quick" type connectors shall be used in connection with any wiring.

Control wiring will be No. 3.5mm.sq. or No. 2.0mm.sq. stranded copper cables, terminated with terminals similar to those described above. CT secondary cable will be 8.0mm.sq. with copper shielding unless otherwise specified.

Terminals for external connections shall be arranged for consecutive connection of conductors within one cable. Not more than one external wire will be connected to each outgoing terminal point.

In the Contractor's internal wiring, not more than one wire shall be connected to one terminal block point, except where jumper wires are needed, in which case two wires may be connected for internal wiring.

If accidental short circuiting of certain wires can result in malfunction of equipment, such as closing or tripping of a breaker, these wires shall not be terminated on adjacent terminal board points.

Detail wiring diagrams shall be made using a cross-indexing notation.

All current transformer terminal blocks shall have shorting provisions with all parts provided with the terminal blocks. Short circuiting of any of the terminals of any one current transformer shall not short circuit the terminals of any other current transformer. Current transformer cables shall have a sufficient service loop so as not to interfere with removal of other devices in cabinet.

Each current transformer circuit shall be arranged and terminated for external connections, as a two wire circuit and each set arranged with Phases 1, 2, 3, N from top to bottom, left to right, front to back.

Required grounding of each circuit shall be by connection to the internal ground bus, provided by the Contractor.

Wire raceway space around terminal blocks shall have a minimum cross section of 100 cm. sq. which shall be equally distributed on both sides of the terminal blocks for ease in terminating the wires.

All power and control wiring external to the control cabinets shall be installed by the Contractor in non-corroding metal cable raceway systems. When not feasible, flexible conduit may be used.

The Contractor shall provide a weatherproof terminal cabinet for terminating all external auxiliary wiring. This cabinet shall be provided with external sunshade sheets of stainless steel rigidly fixed by appropriate spacers in a certain distance not exceeding 20 mm around the cabinet and onto front door. The bottom of the terminal cabinet shall be equipped with removable blank cover plate on which four (4) knock-out type holes suitable for 80 mm rigid steel conduit shall be provided. Sufficient length of this rigid steel conduits shall be included in the scope of supply by the Contractor.

Space heaters shall be provided in each cabinet, including cabinets for annunciator and potential devices. The heaters shall be sized to provide a minimum temperature rise of 5^0F above ambient temperature. Low-high

temperature alarms shall be provided as well as high temperature cut-off. Heaters should be protected against unintended touch.

All equipment installed in the cabinets shall be designed for a cubicle inside temperature of at least 70°C. Grounding wires for cabinets and related doors shall be of highly flexible stranded copper having a cross section of at least 14mm^2.

Rigid pockets (drawing holders) for storing all related drawings shall be securely fixed on the inner side of the front doors of the cabinets.

EW-2.3.4 Relays, Instrumentation and Control

EW-2.3.4.1 General

The Contractor shall provide all standard relays, instrumentation and control as well as the equipment specified hereunder. Whenever specified, the Contractor shall provide alarm contacts and shall wire them to the annunciator specified in Section EW-2.3.4.2.

EW-2.3.4.2 Relays and Instrumentation

Buchholz Relay

If a conservator tank is used, a Buchholz relay shall be mounted in the pipe connecting the conservator to the transformer tank.

This relay shall have two sets of contacts, completely and electrically isolated from each other. One set is intended for alarm and shall close for slow gas flow. The other is intended for transformer tripping or de-energization and shall close for rapid gas flows and oil rushing resulting from heavy fault. Contacts shall be ungrounded, normally open.

This relay shall be so arranged and designed that its active parts are accessible for inspection, repairs and replacement even when the transformer is in operation, and shall be of the type that will not operate during earthquake having seismic coefficient value specified in Section B.1.0 of the Technical Data Sheets.

Sudden Pressure Relay

A sudden pressure relay shall be provided when required in the Technical Data Sheets of the transformer or elsewhere in the specification. This shall detect rapid rise of pressure rather than absolute pressure and shall react faster than the pressure relief valve to sudden abnormally high pressures.

When mounted below minimum oil level, it shall not be affected by the normal internal pressure fluctuation caused by the operation of the oil pump.

Gas Monitoring System

When specified in the Technical Data Sheets, the transformer shall be equipped with an Intelligent On-Line Continuous Gas-in-Oil Incipient Fault Monitor and shall include an Intelligent Transmitter with no moving parts and pumps to detect and continuously monitor possible existence of composite value of hydrogen, carbon monoxide, acetylene and other form of gases in the insulating oil. It shall also include a communication controller, to provide remote and local communications, dual level visual alarm indicators and continuous ppm display. The sensing instrument shall be suitable for tropical climate with high humidity and ambient temperature of up to 55°C. All accessories necessary to have this device operate in extremely hot and humid climate shall be provided. The device shall operate on a system voltage specified in the Technical Data Sheets. The device shall provide visual indication and/or operate a closing contact to initiate an alarm when the percentage of total combustible gas reaches a predetermined level (adjustable).

The monitoring system shall be mounted in a suitable location with no internal restriction or in a place where good convection flow exists. It shall not be affected by vibration and oil flow surges resulting from operation of oil coolers.

Pressure Relief Device

A pressure relief valve shall be provided as a standard protective measure for the main tank. Two (2) pressure relief valves shall be provided for transformers with a rating greater than 50 MVA. It shall open and close automatically to prevent excessive pressure rise in the transformer tank.

Pressure relief vents for pressure relief valve shall be provided on both main tank and diverter switch compartment. The vents shall have the highest part not less than the height of their conservators and shall be designed to have the vent outlets face toward the ground with the height about 50 centimeters above the ground level in order to protect splash-over of oil in case the pressure relief valve is operated.

The device shall be provided with weatherproof hand reset contacts for tripping.

Oil and Winding Temperature Detector

When specified in the Technical Data Sheets, winding hot spot temperature detectors of the copper resistance type 10 ohms at 25°C or equivalent shall be furnished together with necessary accessories arranged for remote indication for use with a temperature monitoring/recording equipment. The heater for the detector shall be connected to the secondary of a current transformer winding and shall be located in the oil near the top of the transformer. Leads from RTD's and/or from thermocouple, shall be brought out to terminal block(s) for Contractor's terminal connections. The Contractor shall supply description and details of the winding temperature detector equipment.

Cooling Control

The type of automatic cooling control, and characteristics of electrical circuit for motor drive shall be as specified in the Technical Data Sheets for the transformer. Control design features, unless specified otherwise in the Technical Data Sheets, shall be as follows:

a. One winding temperature replica shall be furnished to measure the winding temperature in each two-winding transformer with capacity lower than 50 MVA. For transformer with capacity higher than 50 MVA, two (2) sets of winding temperature replica, one (1) for HV winding, the other for LV winding with their contacts in parallel shall be required. For three winding transformers, one simulator for each of the windings shall be furnished. Temperature simulator for three-phase transformers shall be responsive to loads on the center phase. Each simulator shall be furnished complete with associated equipment, including current transformer, heater well assembly, temperature detector and necessary wiring and capillary tubing. The dial indicators shall be accurate within 2 percent of full scale over a range of 150^0C.

b. Hot spot temperature contacts shall be furnished as follows:

    1. One contact to start the first set coolers
    2. One contact to start the second set of coolers, if two step cooling is required
    3. One back-up contact to start both sets of coolers, if the normal starting control failed
    4. One contact for alarm
    5. One contact for trip

c. Top oil temperature contacts shall be furnished as follows:

    1. One contact to stop the second set of coolers, if two step cooling is required
    2. One contact to stop the first set of coolers
    3. One contact for alarm
    4. One contact for trip

One or more manual power selector switches shall be mounted on the transformer to permit the use of each cooler group for either the "Run", "Energizing" or the "Thermal" sequence. The switches shall be located so that they may be operated without opening the control cabinet.
Alarm contacts (wired to the annunciator) shall be provided to indicate failure of the control sequence or power supply for each cooler group.

When a one-step automatic control is specified for forced cooled transformers, all cooler group motors shall be connected to start simultaneously.

If two stages or steps of cooling is specified in the Technical Data Sheets, then the following should be observed by the Contractor:

First sequence when output of transformer reaches OA rating at temperature T_1 for first stage cooling	-	half of the cooling units should start simultaneously
Second sequence when output of transformer reaches FA or FOA or FOW rating at temperature, T_2 for second stage cooling	-	the remaining half of the cooling units should start simultaneously; the back-up contact should function at this temperature, if the normal stage cooling process is not successful.
Third sequence at temperature T_3	-	an alarm will be activated
Fourth sequence at higher temperature, T_4	-	tripping function should activate

With temperature decreasing, the third and fourth sequence contacts shall open within 5^0C below the closing values.

For forced oil-cooled transformer one oil flow indicator shall be installed in the oil line adjacent to each oil pump. Alarm contacts shall be provided which will indicate failure of the oil pump to operate when the cooling equipment is energized. A time delay shall be provided to prevent unnecessary operation of the alarm during pump starting.

Each group of fans and pumps shall be provided with a common circuit breaker for short-circuit protection (this is in addition to overload protection of individual motors) and a common magnetic contactor. Each contactor shall have two spare auxiliary contacts, field adjustable to normally open or normally closed.

Each contactor coil circuit shall be protected by a separate thermal-magnetic circuit breaker. The circuit to coil leads shall be brought to a separate set of terminals in the control cabinet.

Cooling equipment groups for the transformer unless otherwise specified in the Technical Data Sheets, shall operate in parallel from the same power source with means provided to de-energize and isolate one group while the others remain in operation.

Each motor shall be provided with an overload protection device with adjustable current setting range (manual reset type).

All pressure relief devices shall be furnished with alarm contacts wired to the annunciator specified below.

Annunciator

When specified in the Technical Data Sheets, the Contractor shall furnish a solid-state annunciator in a separate NEMA Type 3R cabinet. The rain hood shall prevent entrance of rain at a level higher than the lowest live part. The cabinet shall contain for the annunciator externally operable lamp test and reset controls; two external indicating lamps and one nameplate for each alarm point; and a thermostatically controlled cabinet heater. The annunciator shall have alarm retransmitting contact with reflash capability, all wired to terminals to permit easy grouping and connection by NPC (for Supply Contract) or Contractor (for Turnkey contract) to remote annunciator panel in the control room.

Transparent window shall be provided in the control cabinet in order that all individual trouble indicated on the annunciator panel can be visualized without opening the control cabinet cover. Spares completed with accessories of four annunciator windows shall be provided in addition to the windows required.

When any trouble contact is closed, the corresponding auxiliary relay of at least two independent contacts, one for signal lamp on annunciator panel and the other for remote indication shall be energized and self-held which shall be reset by the reset push button only if fault has cleared.

Separate terminals shall be provided for each contact for remote indication.

If there are more than one fault occurring simultaneously, windows shall be annunciated correctly and only a fault that has been cleared can be reset with the reset push button.

The tripping circuit part shall be independent from the annunciator circuit part in order that tripping is still possible while annunciator circuit is off.

EW-2.3.5 Accessories

EW-2.3.5.1 General

The Contractor shall furnish all standard accessories as well as the equipment described herein.

EW-2.3.5.2 Spill Gaps and Arresters

When specified in Technical Data Sheets, surge arresters and spill gaps shall be provided.

Spill gaps of rugged design shall be incorporated in the transformer assembly on the exposed terminals designated in the Technical Data Sheets. Taps shall be mounted that bushing weather casing, gage glass, seal, or any other equipment or parts of the transformer shall not be damaged in the event of a flashover of the gaps. Spill gaps shall be rod gaps of standard design. Design of gaps, settings, and method of mounting on the transformer shall be those which have proven satisfactory in service and shall be subject to review by NPC. Ranges of adjustment and factory settings shall be in accordance with the following tabulation for the insulation levels of the respective windings.

Winding Insulation BIL kV	Spill Gap Settings Millimeters (Inches)		
	Adjustable		Factory Setting
	From	To	
95	25.4 (1.0)	101.6 (4.0)	63.5 (2.5)
110	38.1 (1.5)	114.5 (4.5)	76.2 (3.0)
150	76.2 (3.0)	152.4 (6.0)	114.3 (4.5)
200	127 (5.0)	228.6 (9.0)	152.4 (6.0)
250	177.8 (7.0)	279.4 (11.0)	203.2 (8.0)
350	254.0 (10.0)	457.2 (18.0)	304.8 (12.0)
450	330.2 (13.0)	609.6 (24.0)	406.4 (16.0)
550	406.4 (16.0)	711.2 (28.0)	520.7 (20.5)
650	508.0 (20.0)	889.0 (35.0)	660.4 (26.0)
750	635.0 (25.0)	1016.0 (40.0)	762.0 (30.0)
825	685.8 (27.0)	1168.4 (46.0)	838.2 (33.0)
900	787.4 (31.0)	1270.0 (50.0)	914.4 (36.0)

For a BIL up to and including 200 kV, exposed gaps shall be of double series gap type or equivalent to minimize interference from birds, and settings shall be adjustable in steps not greater than 6.35 mm (1/4 inch). For a BIL above 200 kV, gaps shall be adjustable in steps not greater than 12.7 mm (1/2 inch). On multiple series gaps, the sum of the separate gap setting shall equal the tabular settings. Spill gaps shall not be furnished for windings rated greater than 245 kV, unless otherwise specified in the Technical Data Sheets.
Surge arresters shall be supplied in accordance with ratings and requirements specified in the Technical Data Sheets. Arresters will be mounted by NPC on brackets furnished by the Contractor and attached to the main tank at locations convenient to the associated bushing.

a. When surge arresters are mounted on the transformer, all hardware and tubing for connecting arresters to bushing terminals shall be provided by the Contractor. Connections between transformer bushings and surge arresters shall be sized to carry the full rating of the transformer continuously.

b. The height of the bracket shall be adjusted so that the top of the arrester is at about the same elevation as the bushing terminal, but such that the lowest porcelain will be at least 2300 mm (7 ft. 6 in.) above the base of the transformer.

EW-2.3.5.3 No-Load Tap Changer

When specified in the Technical Data Sheets, tap changers shall be mechanically and electrically rugged, arranged to provide for convenient inspection and maintenance without necessity for untanking and provided with an external mechanism for manual operation. The tap changer, as well as the arrangement of leads and connections thereto, shall be designed for transient voltage conditions. The external mechanism shall be protected against authorized operation and provided with positive indication of the tap in use and so located that it may be observed without need for unlocking the

mechanism. Its location shall be on the wall of the tank so that inspection is permitted without de-energizing any circuit.

To prevent mis-operation of the off-load tap changer while the transformer is still energized, two (2) sets of interlocking contacts, one for alarm and the other for tripping-off the circuit breaker with the provision that the circuit breaker shall be tripped before the possible operation of the off-load tap changer, shall be provided. The interlocking mechanism shall be provided with steel cover and/or padlock.

The tap changing mechanism shall be designed so that they can be operated conveniently by a man standing on the same level as the transformer base, and shall include an operating handle, indicating pointer and dial and means for locking the tap changer in any desired position. The locking device shall be arranged to prevent locking the tap changer in an intermediate position.

The mark to indicate the position of the tap changer shall also be provided at the transformer tank where the tap change mechanism shall enter the transformer tank, so that if the shaft linkage is broken or loosen, the top position is evident.

EW-2.3.5.4 On-Load-Tap Changing Equipment

When specified in the Technical Data Sheets for the transformer, the on-load-tap changing equipment shall consist of a tap selector with change-over switch and a rotary diverter switch of the high-speed transition resistor type (principle Dr. Jansen), a motor driven mechanism, as well as automatic control devices suitable for remote operation. All equipment related to LTC shall come from original LTC manufacturer. Licensee products are not acceptable. The mechanical and electrical requirements for arc interruption, compartmentation, automatic control, parallel operation with similar transformers, instrumentation, accuracy and burden of instrument transformers shall be those specified in ANSI C57.12.10 or IEC 60542. The oil in the switching compartment shall be kept separated from the oil in the main tank.

Overall design shall be simple and rugged, with arcing contacts suitable for long life. It shall be mechanically capable of performing 500,000 operations, and the tap changer contacts shall be capable of performing 200,000 operations at full load without parts having to be replaced or rebuilt, and at least 50,000 operations without maintenance required. Each completely assembled tap changer shall be capable of withstanding, in any tap position, without damage the maximum short circuit stresses which would be imposed upon it when the transformer itself is subjected to short circuit currents in accordance with the requirements of ANSI C57.12.00 and Section EW-2.3.2.5. Overload currents allowed for the transformer shall be matched by the LTC, i.e. the permissible continuous through-current at rated switching capacity shall correspond at least to the current for long time emergency cyclic loading as specified in IEC 60354 at highest current tap.

The moving contact assembly shall be self-aligning and when in closed position, heavy contact pressure shall be applied. All current carrying parts shall be of sufficient area and cross section to insure that the temperature rise

does not exceed 10^{0}C above adjacent bushing standard temperature under full load conditions. For star-point applications, the tap changing device shall be designed to withstand the applied potential tests of the winding to which it is connected; and for all applications where LTC are connected directly to the line terminals of any of the windings (e.g. in auto-transformers) they shall be insulated for at least two basic impulse insulation levels (BIL) higher than that as specified for the related line terminals.

In case of non-linear protective elements and/or tie-in resistors being provided, this shall be clearly indicated in the connection diagram. In case of tie-in resistors being provided at the middle of any regulation winding, they shall be connected via potential switches to the take-off terminal of the tap changer so that power dissipation only occurs during the short potential switch operation time. Any resistor made of graphite elements will not be accepted.

The LTC equipment shall provide a range of regulations and percentage of each step as specified in the Technical Data Sheets.

Local and remote control and indication for the LTC equipment shall be furnished.

The design of the tap changing equipment shall be such that the mechanism will not stop in any intermediate position, however, if the mechanism through faulty operation does stop in an intermediate position, full load must be carried by the transformer without injury to the equipment.

The mechanical position indicator shall be equipped in the motor drive cubicle. The LTC motor shall be designed to be of step control, which in any case the operation shall be of step by step.

The LTC shall be provided with overcurrent protective device in order to prevent the tap-change operation during a short circuit, which would too greatly stress the contacts of the diverter switch.

A voltage regulating relay shall also be supplied together with the timer and undervoltage relay which would signal and execute the tap changer operation when the regulating voltage is out of the voltage regulating level and shall be designed to be delayed by the timer with the setting time of 0-60 seconds.

The LTC circuit of the transformer shall be completely designed and provision shall be made for future parallel operation with another transformer, if required in the Technical Data Sheets.

The Contractor, if so stated in the Technical Data Sheets, shall supply a complete transformer operations control system mounted on an indoor free standing cabinet or a 19-inch standard rack equipped with the following control and protective devices, as a minimum;

a. tap changer controls plug-in module comprising of:

   - "remote automatic", "local automatic", "manual", "off" selector switch

- "raise/Lower" control switch
- digital tap position indicator

b. microprocessor based voltage regulating unit following the step-by-step principle and comprising of:

- overvoltage detection and automatic return control
- undervoltage and overcurrent blocking
- line drop compensation
- load shedding capability

c. Parallel control device for automatic synchronized control of tap changers following the principle stated in the Technical Data Sheets and suitable for the required number of transformers to be operated in parallel as specified in the Technical Data Sheets.

d. Temperature and gas monitoring devices

The function of the transformer operation control system panel shall be incorporated in the microprocessor-based substation control system (MBSC) for the substation, if required in the Technical Data Sheets.

In addition, the Contractor shall furnish and mount the following control devices in the transformer control cubicle:

a. "Remote-Local-Test" selector switch can be operated only in the test position;

b. "AUTOMATIC-MANUAL" control switch;

c. "RAISE-LOWER" control switch of automatic or spring returned type to an intermediate "OFF" position for manual control of the motor-operated tap changer;

d. Tap position receiver indicator. The tap position shall be indicated by..IL, N, IR;

e. Under voltage relay and timer for voltage regulating relay

f. Three-phase under voltage relay for AC supply

g. Under voltage relay for DC supply

h. Control and auxiliary relays

i. Voltmeter

The Contractor shall also furnish and mount the following control devices on the LTC driving mechanism:

a. "RAISE-LOWER" push-buttons;

b. Means for manual operation when power supply is lost;

c. Tap change operation counter with two sets of 5 digits registering number, one set for registering the accumulated number of tap change performed and another set with resetting knob for possible recount of tap change performed.

d. Step by step operations control devices;

e. LTC parallel operation checking device provided for possible future installation of other identical LTC power transformer;

f. Device for transmitting the tap changer position to the tap position receiver indicators located at the transformer control cubicle and remote transformer operation control system located at the control room;

g. Multi-tap resistor device with number of taps equal to number of required tap positions for possible remote tap position indication by telemetering through the tap position indication by telemetering through the tap position transducer;

h. Hand lamp controlled via door switch;

i. Space heater with thermostat and humidity control.

NOTE: Any alternative provision for possible remote tap position indication by telemetering may be considered if it complies with the NPC's requirement and shall be subject to NPC's approval.

The motor drive mechanism shall be housed in a weatherproof and corrosion-proof steel compartment or cast aluminum which will contain all the necessary devices to perform the proper tap changer operation both for local manual and automatic remote transfer operation.

Space heaters shall be located in the lower portion of the control housing with connections made from below to minimize deterioration of supply wire insulation. The space heaters shall be encased in an electrical insulating sheath. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheath or other components in the housing. The thermostats in the heater circuit shall be adjustable from 5^0C to 25^0C.

EW-2.3.5.5 Anti-Earthquake Clamping Device

To keep the transformer from moving during earthquake, the Contractor shall provide a clamping device which is fixed to the foundation. The bolts for this clamp will be embedded in the concrete foundation so that the transformer, when positioned properly, maybe fixed securely. The transformer can be fixed to, or unfastened from these bolts as desired.

EW-2.3.5.6 Oil Filter Units

If required in the Technical Data Sheets, stationary oil purification plants for drying and cleaning of the insulation oil in intermittent operation shall be provided for all on-load tap changers connected to line terminals of auto-transformers.

The oil filter unit shall comply with the required technical characteristics specified in the Technical Data Sheets.

There shall be no air bubbles in the filtered oil return from the filter units to the OLTC so that the units can be operated when the OLTC is in service.
The oil filter unit shall be automatically operated after each tap change operation. The operating time for the pumps shall be adjustable from 10 to 180 minutes. Moreover, an integrated time switch shall control the pump units in intervals of two hours per day independently of switching operations.

The oil filter unit shall be of integral type, each having pump and filter element combined in one filter tank. The filter tank shall be fixed at the transformer tank on suitable mounting brackets at an approved location. The filter tank shall be equipped with a pressure gauge with contact, temperature compensated by serial oil temperature switch, for initiating of a signal in case of overpressure. The filter tank cover shall be removable for a ready access to each filter unit for inspection and replacement.

The pumps and filter elements shall be designed to operate with high temperature oil (approx. 100°C) and shall not react with mineral oil. The filter elements shall be of the combined type to remove any solid foreign substances and water in the oil. The feed and return pipes of the filter tanks shall have minimum 25 mm inside diameter with standard flange connectors to be connected to the filter unit via isolating valves. Appropriate oil sampling valves shall be provided between the isolating valves and the oil filter units. Suitable air release and drain plugs shall be provided for each filter unit.

The oil filter unit shall include a weatherproof and corrosion proof control cabinet, rigidly framed and fabricated from 2-mm minimum thickness sheet steel.

All electrical components necessary for the proper operation and supervisory control of the oil filter unit including power connections shall be housed in the control cabinet.

The control cabinet shall be suitable for mounting on the transformer tank and shall not be affected by the vibration caused by the operation of the cooling units of the transformer. It shall be vermin proof, dust proof and weatherproof. Suitable door gaskets made of rubber shall be provided to prevent the ingress of moisture etc.

Access to all compartments shall be provided by hinged doors. Bolts or carriage keys shall not be used to secure the panels or doors. All fastenings shall be integral with the panel or door and provision shall be made for padlocking. Sufficient openings in the base of the control cabinet shall be provided for the incoming cables and entrance shall be accomplished using glands to fix and seal the cubicles.

The cubicles shall be furnished with space heaters with thermostat setting as well as one 20-watt fluorescent lamp and one duplex convenience outlet with rating specified in the Technical Data Sheets. The heaters shall be sized to provide minimum temperature rise of 5°F above ambient temperature.

Low-high temperature alarm shall be provided as well as high temperature cut-off. A manually 2-pole operated disconnect switch shall be provided to open and close both sides of the circuit for maintenance purpose.

Grounding terminals shall be provided at the bottom of all the panels for earthing. It shall be suitable for accepting 100 mm² stranded copper conductor.

EW-2.3.5.7 Silicagel Breathers

The conservator vessel shall be fitted with two parallel breathers in which only blue silicagel (pink colored when wet) has been filled as a dehydrating agent. The containers for the dehydrating agent and the oil trap shall not be of transparent plastics.

The parallel breathers shall be connected to the air expansion pipes via two-position three-way valves with captive screwed caps. The three-way valves shall control the breathers in such a manner that each of the two parallel breathers can be in service while the other breather is in stand-by position, i.e. it must be possible to switch-off each of the two parallel silica gel breathers of the same group individually while the other one is still in operation. Any position other than specified above shall be mechanically interlocked.
In view of the excessive humidity, the breathers shall be larger in size and shall be provided with oil trap. The silica gel filling capacity of each breather shall be dependent on the size of the transformer (each having a silicagel filling capacity of minimum 3 kg for LTC conservators, 4 kg for main conservators of transformers up to 25 MVA per unit and 6 kg for transformers up to 100 MVA per unit, and minimum 8 kg for transformers above 100 MVA per unit shall be provided). The silica gel breathers and the three-way valves shall be rigidly fastened at an accessible position in a convenient floor height. For this purpose, the breathers shall be also fixed onto the tank by solid mounting brackets at the lower ends.

EW-2.3.5.8 Transformer Explosion and Fire Prevention System

If required in the Technical Data Sheets, the transformers shall be equipped with Transformer Explosion Prevention and Fire Prevention/Protection System. The system shall be complete in all aspect to perform the required functions and shall include not only of the transformer tank explosion prevention and fire protection but also of the on-load-tap changers and the oil bushings or oil cable boxes using the principle of Rupture Disk with Integrated Explosion Detector coupled with Nitrogen Injection.

For power transformer having the oil filtration or filter units for the OLTC, the same shall be included in the explosion prevention and fire protection system for the transformer. The system shall ensure a complete protection for the transformer tank, on-load-tap changer, oil bushings and the oil filtration units from any explosion in case of occurrence of any kind of short-circuits.

The principle of operation shall be such that in the event of high intensity fault resulting to excessive energy or dielectric oil overpressure, the system shall initiate the depressurization process. This is done with the activation of the

rupture disk with an explosion detector which shall then give the high pressure information when short circuit occurs. Immediately after depressurization, nitrogen flow shall forbid the self-inflammable gases contact with air (oxygen). However, nitrogen injection process shall operate only with the presence of the following signals:

a. The activation of any of the integrated rupture disk explosion detector confirming the overpressure state and the beginning of the depressurization process; and
b. The activation of any of the electrical protection signal, confirming the electrical fault of the protected transformer.

The system operation shall be properly coordinated with the required input to avoid mal-operation and malfunction of the total system. Activation of only one signal among the conditions stated in this section shall prevent the operation of nitrogen injection process and shall only generate remote annunciation/signal at the control room. Only at the presence of both signals shall the electrical actuator triggers the nitrogen injection process.

The nitrogen injection function shall:

a. immediately stops the explosive and flammable gas production (hydrogen, methane, acetylene, etc.);
b. evacuate the explosive hydrogen stocked in the tank upper parts;
c. replaces the generated explosive and flammable gases by a nitrogen atmosphere inside the vessel;
d. avoid air-oil contact by slightly pressurizing the transformer with nitrogen gas;
e. limit the damage caused by temperature gradient in the metal parts;
f. completely cools down the transformer by injecting nitrogen at the required time (normally 45 minutes) to bring the short-circuited parts temperature down below the oil flash point.

It shall be that when the system operates, the oil from the conservator will be automatically isolated from the main tank and the OLTC, preventing the drawing of the oil from the main tank and the OLTC. Means shall also be provided in preventing the contact of air with the explosive and flammable gases before its evacuation towards a draining pit located at appropriate location. In case of oil flow, during the activation of the system, the system shall drive the oil straight inside the oil duct.

The design of the nitrogen injection process shall also include manual activation of the nitrogen in the event that the DC power supply source for the Transformer Protector System fails.

All alarm signals associated with the Transformer Protector System i.e., AC, DC power supply failure, nitrogen cylinder low pressure alarm, system actuation audible alarm, etc. shall be sent to the control room at the control board annunciator system.

For substation being controlled with Microprocessor Based Substation Control (MBSC) System, these alarms shall be incorporated and interfaced with the MBSC. The design of the schematic diagram and logic for the Transformer

Protector System shall be incorporated in the MBSC and can be accessed in the Operator Machine Interface (OMI) screen of the MBSC. It shall be possible that when the system operates, important action such as, isolation of conservator tank, injection of nitrogen, etc. can be monitored in the screen of the OMI.

The design of the transformer protector system shall be such that in maintaining the power transformer, the system can be isolated without affecting any of its components. All accessories necessary for this purpose shall be included in the scope of supply for the transformer protector system.

If required in the Technical Data Sheets, the explosion and fire prevention shall be backed up with a Nitrogen Fire Extinguishing System known as the "Drain and Stir" System. The principle shall consist of injecting nitrogen at the transformer base to extinguish the fire.

Just like the Explosion and Fire Prevention System, injection of nitrogen can be activated only in the presence of the following signals:

a. The activation of any of the fire detector confirming the occurrence of fire; and
b. The activation of any of the electrical protection signal, confirming the electrical fault of the protected transformer.

The system operation of the backup system shall be properly coordinated with the required input to avoid mal-operation and malfunction of the backup system. Activation of only one signal among the conditions stated in this section shall prevent the operation of nitrogen injection process and shall only generate remote annunciation/signal at the control room. Only at the presence of both signals shall the electrical actuator triggers the nitrogen injection process.

Fire detectors for the backup system, shall be located at appropriate location in the tank, OLTC, oil bushings and oil filter units (if oil filter units are required for the transformer).

The design of the whole system shall be submitted to the NPC for review and approval before any manufacturing has to be done for the Transformer Explosion Prevention and Fire Protection/Prevention System.

All devices, required fittings, piping, control cabinet, detectors and accessories necessary to fulfill the function of a complete Transformer Explosion and Fire Prevention System and the Backup System shall be furnished and included in the cost of the transformer.

The Transformer Explosion Prevention and Fire Protection/Prevention System shall be suitable for outdoor installation and shall not be affected by the operating environmental conditions specified in the Technical Data Sheets.

EW-2.3.5.9 Other Accessories for the Transformer

In addition to the accessories mentioned above, the following shall also be included in the scope of supply for the transformer:

a. Oil level gauges with low level alarm contacts for main conservator and diverter switch conservator;

b. Oil temperature – oil level curve plate;

c. Separate ground terminal connectors of bolt fastened type provide for the following:

1. LV lightning arresters
2. TV lightning arresters
3. Neutral bushing
4. Tertiary bushing for grounding purpose (if any)
5. Transformer Tank

NOTE: The ground terminal connectors shall be suitable for the grounding cable that will be applied by the Contractor, but should not be less than 100mm^2. Depending on Contractor's option, all ground leads shall be insulated ground wire, or combination of insulated ground cable from the arresters down to the operating counters and 30 x 5 mm copper bar fixed by porcelain insulators on the transformer tank for the rest. All ground leads shall be connected from the above-mentioned equipment to ground terminal connectors.

d. Handholes and/or manholes for servicing. Dimensions to be provided by Contractor for NPC's approval;

e. Suitable pulling eyes and lifting lugs in addition to the jacking pads;

f. Lifting device fixed on transformer tank for lifting-off the LTC; and

g. Removable step ladder which can be attached and bolted on the transformer tank for servicing the transformer.

EW-2.3.6 Equipment Marking

In addition to the provisions of Section EW-1.13, plates made of corrosion-proof material rigidly supported shall be supplied as specified hereinafter. Nameplates mounted outdoor shall be of polished stainless steel of top quality only (background clear, engraving black, depth of engraving 0.5mm).

Nameplates mounted inside control and marshalling cubicles may be of material in accordance with manufacturer's standard, e.g. glass-fibers reinforced synthetic resin subject for approval by the NPC. All plates other than those located on tank cover shall be easily and clearly legible from ground level.

In general, the following nameplates for the transformer shall be provided:

- A rating plate. The transformer's nameplate shall contain the information outlined in ANSI C57.12.00, Paragraph 5.1.2.

- A connection diagram showing in an approved manner the internal connections and the vector relationship of the several windings and, in addition, a plan view of the transformer giving the correct physical relationship of the terminals.

- A diagram plate indicating the oil levels in the conservator dependent on the oil temperature.

- A plate showing the location and function of all valves and air release cocks, plugs and all monitoring equipment in the plan view and in different elevations of the transformer. This plate shall also warn the operator to refer to maintenance instructions before applying vacuum treatment and not to operate vacuum application and vacuum equalizing valves after oil filling under vacuum.

- A loading plan plate showing transport dimensions and masses. This plate shall also warn the erection staff, not to remove any cover before filling the tank with oil to such a level where the windings are not exposed to the atmosphere. This plate shall be fixed directly onto the transformer tank and shall not be removed for transport.

- Identification plates, alpha-numerical numbered in an approved manner, for all fans, marshalling cabinets, breathers, valves, cocks, accessories etc. (minimum size: 110 mm x 50 mm) rigidly fastened by rivets on corrosion proof base plates. In addition, the function (description) of the related devices shall be clearly indicated on these plates. The alpha-numerical numbers on the identification plates shall be of such a size as to be clearly legible from the floor level.

- Plates showing all control, measuring and monitoring circuits and terminal blocks. These plates shall be rigidly fixed at the inner side of the hinged door of the concerned marshalling kiosk.

- Plates showing the control circuit/block diagram of the LTC. These plates shall be rigidly fixed at the inner side of the hinged door of the motor drive cubicle.

EW-2.3.7 Other Technical Requirements for the Transformer(s)

Other features for the transformer, if required by the NPC are stated in the Technical Data Sheets.

EW-2.4 INSTALLATION

Installation will be by the Contractor unless specified otherwise in Section B.1.0 of the Technical Data Sheets.

When the installation is by Contractor, such as for turnkey contracts complete details of proper handling, transport and storage, installation, testing and

commissioning, performance, guarantees, etc. shall be provided for NPC's review and approval.

EW-2.5 FACTORY ASSEMBLY AND TESTS

EW-2.5.1 General

Each transformer shall be completely assembled and adjusted at the factory and given the manufacturer's routine shop tests and also other test as specified herein. All parts shall be properly marked for ease of assembly in the field. All tests required herein shall be witnessed by the NPC or his authorized representative unless waived in writing, and no equipment shall be shipped until released for shipment by the NPC or his authorized representative.

The test equipment, test methods, measurements and computations shall be in accordance with the latest applicable requirements of ANSI C57.12 and/or IEC60076.1 Parts 1-5, except in cases where otherwise set forth, and shall be subject to the approval of the NPC.

EW-2.5.2 Shop Tests

Routine, design, "other" tests and optional tests, if specified in the Technical Data Sheets, shall be performed in accordance with ANSI C57.12.00 and ANSI C57.12.90 and/or IEC 60076, except as modified by the requirements of the following paragraphs. If a transformer fails to pass the tests specified, additional tests shall be made to locate the failure, and after reconstruction, testing shall be repeated to prove that the rebuilt transformer meets the specification in all aspects.

The standard tests are modified and supplemented as follows:

No-load loss and exciting current shall be measured from 90 to 120 percent of rated voltage in 5% intervals, and a respective magnetizing curve shall be drawn and added to the test report. No-load loss shall be measured at rated voltage both before and after impulse tests. Also refer to Section EW-2.3.2.9 for tolerances.

Temperature rise test shall be performed as specified with all current carrying accessories (CT, etc.) in place. Tap connection(s) giving the highest winding temperature rise shall be used. In case of auto-transformers, the winding temperature rises shall be determined in the applicable highest current taps each for both, the common and the series winding. In case of any kind of forced air cooling the bottom oil temperature shall be measured only in headers affected by the forced cooling. The oil temperatures shall be measured at the inlets and outlets of the headers of the coolers by thermo-couples installed directly in the oil-flow. Measurements of top oil temperatures taken in pockets shall be corrected by +3 K independent on the applied standard. Measurements on radiator/cooler walls are not acceptable.

If allowed in the Technical Data Sheets, duplicate temperature rise tests will be acceptable only to transformer having a maximum cooled rating capacity

lower than 100 MVA and on the evidence that the total average losses do not exceed 105 percent of a previously tested and accepted duplicate unit. The Contractor shall submit the serial number, rating, a copy of the test report for the duplicate unit and justification as to classifying it as a duplicate. No duplicate temperature rise tests will be accepted for transformer having a maximum cooled rating capacity greater than 100 MVA. Temperature rise test shall be performed on each transformer with a capacity greater than 100 MVA.

If winding temperature equipment are specified, data shall be included for calibration of hottest spot temperature indicator. These tests should be conducted on each phase at the highest and lowest rating.

Temperature rise tests shall include a thorough examination of the tank wall surfaces to detect hot spots during the temperature tests.

During temperature rise tests of generator step-up transformer, the top of the tank temperature in the vicinity of the low voltage bushing outside where the isolated phase bus ducts join the transformer shall be taken and these locations shall be marked permanently so that they can be repeated with the bus installed.

The zero sequence impedance (when transformer design results in a zero sequence impedance different from that of the positive sequence), insulation power factor, and capacitance for each winding to ground and between windings shall be measured and recorded.

Impulse tests, if specified in the Technical Data Sheets, shall be applied in accordance with ANSI C57.12.00 and C57.98 and/or IEC 60076-3 and the procedure outlined in the following paragraphs and shall be officially witnessed by NPC's representatives. No impulse voltage application shall be made to transformer prior to tests officially witnessed by NPC's representative without specific written approval by NPC.

Nothing in the preceding paragraph shall be construed to preclude or prohibit the Contractor from making other impulse tests in addition to those specified in the Technical Data Sheets, provided:

a. The conditions previously mentioned are carried out and impulse test record logged as specified below.

b. Prior to shipment, the Contractor shall submit to NPC satisfactory evidence, by wave comparison or other means, that the transformer has not been injured thereby

During impulse and switching surge tests, cathode-ray or approved computerized oscillogram shall be made of the currents in grounded ends of windings being tested.

During each impulse test, spill gaps shall be temporarily removed from the terminal or terminals to which impulse voltage is to be applied.

Impulse Test Log

The Contractor shall maintain a complete log of all impulse voltage applications to transformer terminals, including all preliminary or calibrating tests as well as final tests. This log shall include a record of the nature of each test, oscillogram identification, test gap settings, connection of all transformer terminals, atmospheric conditions, number of waves and values of voltage applied, timing of wave and a record of any observed evidence of flashover of gaps, bushings, protectors in the test circuit, and any disturbance, or test failure, interior or exterior of the transformer. This log of impulse test circuit drawings shall be available to NPC at all times.

A cathode-ray oscillogram or an approved computerized oscillogram shall be taken of each impulse voltage applied to transformer terminals, including all preliminary or calibrating tests, as well as final tests. All oscillogram negatives, including oscillogram of current in windings tested, shall be permanently available for NPC's examination at Contractor's plant and the Contractor shall deliver copies of this file to the NPC.

a. When reproduced in report form, they shall be neatly presented and arranged so that the necessary comparisons between reduced and full magnitude waves can be conveniently made from the report

b. The amplitude of each test wave on the oscilloscope shall be adjusted to vie as large a deflection as possible. The waves intended for comparison shall be of identical amplitude.

c. The effect of internal surge limiting devices on the oscillographic record also shall be pointed out

A description, including drawings of the general test setup, comprising impulse generator, the circuit constants used for the terminals under test, and the connection of windings not tested shall be submitted to NPC.

If one-hour low-frequency induced dielectric test is required in the Technical Data Sheets, the transformer should be connected as for service and the tap changer shall be adjusted such that the ratio for primary and secondary winding is as close as possible for the related highest system voltages for equipment, and the test shall comprise applying or inducing $\sqrt{3}$ times the highest system voltage for equipment / $\sqrt{3}$ (against ground) to the transformer terminals for 120 x (rated frequency)/ (test frequency) seconds (but not less than 15 seconds), after which the test voltage should be reduced to 1.5 times the highest system voltage for equipment / $\sqrt{3}$ (against ground) and held for one hour. Partial discharges should be monitored continuously throughout the test and recorded every five minutes and should not exceed a mean value of 300 pC during the last 60 minutes of test. Continuous discharges of short duration and at irregular intervals can be accepted up to 500 pC provided that there is no increasing tendency.

The sequence of specified tests shall be as follows:

Short Circuit Capability

If required in the Technical Data Sheets, this test shall be performed whenever the testing facilities are suitable for full scale test. If such full-scale test is not feasible, a model test shall be performed.

If tests are not specified, the Contractor shall submit his related design criteria, short circuit effects calculations and design countermeasures for NPC's review.

Test reports on duplicate transformers lower than 100 MVA rating are acceptable, unless tests are specified. The validity of these test reports shall be justified by Contractor's analysis submitted together with the test reports for NPC's review.

Losses (no-load and load) concurrent with exciting current and impedance.

Temperature rise tests at all types of cooling (For auto-transformers one-hour tests for determination of the winding temperature rises shall be conducted each in the applicable highest current taps for both, the common and the series winding).

Switching Impulse Tests

Lightning Impulse: The following test procedure shall be applied for all transformers independent on the applied standard:

a. one 50 – 70% full impulse (lines and neutral)
b. one 80% full impulse (lines and neutral)
c. one 100% full impulse (lines and neutral)
d. one 50 – 70% chopped impulse (line terminals only)
e. two 110% chopped impulses (line terminals only)
f. two 100% full impulses (lines and neutral)
g. one 80% full impulse (lines and neutral)
h. one 50 – 70% full impulse (lines and neutral)

Tests impulses for reference as per item b. g. and h. are required only for winding where non-linear protective elements are installed in the regulation windings and/or LTC. Test impulses on neutral points shall be applied directly on neutral terminals with all line terminals grounded.

Repeat of no-load losses and exciting current

Noise-level test (special test on one unit)

Low frequency dielectric tests:

a. applied potential test

b. short-time induced AC voltage withstand test in accordance with IEC 76-3 or ANSI equivalent and monitoring of partial discharges. On

transformers which have more than one non-uniformly insulated winding, the voltage on the neutral shall be raised by application of a bias voltage by connection of an auxiliary booster transformer to the terminals in question to achieve tests voltages on the line terminals of all non-uniformly insulated windings under tests as assigned in the relevant tables of IEC 76-3 and the tap changer shall be adjusted accordingly. On single-phase units, this auxiliary transformer may be another unit of the same transformer type related to the three-phase bank in question.

c. one-hour low frequency, induced voltage dielectric and partial discharge test

Insulation power factor and capacitance tests at 10 kVac

Tests for unintentional core grounds at 2500 Vdc, 60 sec. to be performed immediately after completion of all other shop tests.

EW-2.5.3 Other Tests

In addition to the tests mentioned above, other equipment attached as an accessory to the transformer, i.e. bushing current transformers, potential device, arresters, etc. shall be tested in accordance with the tests mentioned on the applicable provisions for each of the equipment.

EW-2.5.4 Failure to Meet Guarantees

EW-2.5.4.1 Losses

If the transformer losses, as determined by test, at rated voltage, frequency and 100% rated KVA (on principal tapping) exceed the guaranteed total losses, the excess in losses shall be evaluated at the following rates and the resulting amount shall be deducted from the contract price.

$$S = 2\,[(N_{L\text{-}L})\,(N_{LM1}\text{-}N_{LG1}) + (L_L)\,(L_{LM1} - L_{LG1}) + (Aux_{L1})\,(Aux_{LM1} - Aux_{LG1}) + (Aux_{L2})\,(Aux_{LM2} - Aux_{LG2})]$$

where:

S	=	amount to be deducted from contract price expressed in US $
$N_{L\text{-}L}$	=	price in US$/kW for the no-load losses as stated in Section A.1.3 of the Technical Data Sheets
L_L	=	price in US$/kW for the load losses as stated in Section A.1.3 of the Technical Data Sheets
Aux_{L1}	=	price in US$/kW for the auxiliary cooling losses for stage 1 cooling as stated in Section A.1.3 of the Technical Data Sheets
Aux_{L2}	=	price in US$/kW for the auxiliary cooling losses for stage 2 cooling as stated in Section A.1.3 of the Technical Data Sheets
N_{LM1}	=	measured no-load losses expressed in kW
N_{LG1}	=	guaranteed no-load losses expressed in kW
L_{LM1}	=	measured load losses expressed in kW
L_{LG1}	=	guaranteed load losses expressed in kW

Aux_{LM1} = measured auxiliary cooling losses for stage 1 cooling expressed in kW

Aux_{LM2} = measured auxiliary cooling losses for stage 2 cooling expressed in kW

Aux_{LG1} = guaranteed auxiliary cooling losses for stage 1 cooling expressed in kW

Aux_{LG2} = guaranteed auxiliary cooling losses for stage 2 cooling expressed in kW

EW-2.5.4.2 Temperature Rise

The temperature rise of windings shall be determined by type tests. If, according to the results of the tests carried out within the scope of the contract, the measured temperature rise exceeds the guaranteed value, the price for all transformers of the same type to be paid to the Contractor shall be reduced by a compensation for decreased life expectancy. The compensation shall be computed as follows:

Temperature rise over the permissible limit K (°C)	Compensation of percent of the total FOB price for the transformer
0-1.99	0
2-2.99	4.5
3-3.99	9.0
4-5.00	13.5

EW-2.5.4.3 Rejection

The NPC may, during tests at factory, reject a power transformer for the following reasons:

a. if the tolerance limit specified in Section EW-2.3.2.9 for core loss has been exceeded and any of the losses have reached ten percent (10%) more than the guaranteed losses;

b. if the impedance voltage exceeds ten percent (10%) of the guaranteed value;

c. if the temperature rise exceeds the permitted values more than 5K.

For each rejected transformer, the NPC may, at his own judgment, direct the Contractor to make any necessary corrections or alterations to it or to replace it forthwith. Any and all expenses that might result by the supply and installation of new parts or by the modification of existing parts and any and all expenses resulting in additional tests made necessary by failure of equipment to meet the guarantees and other requirements of the Specifications shall be borne by the Contractor.

EW-2.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-2.6.1 General

Contractor-furnished data and information shall be the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor's furnished equipment. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder. Any deviation from such data requires NPC's approval.

EW-2.6.2 Data and Information to be Submitted with the Proposal

Contractor shall furnish with his proposal the filled-in Section A.1.0 of the Technical Data Sheets.

EW-2.6.3 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the following:

a. Filled-in Section B.2.0 of the Technical Data Sheets;

b. Contractor shall furnish the brochures and catalogues during post qualification to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment/materials being offered

EW-2.6.4 Data and Information to be Submitted After Award of Contract

Final outline drawings showing dimensions: weight; dimensioned location of the transformer center of gravity, completely assembled with oil and as shipped (with oil or gas filled); the dimensioned location of all parts and accessories, the flood level; and the overall height required to remove high voltage and low voltage bushings. The drawings shall clearly show transformer base construction.

The Contractor shall furnish in the manner, number of copies, and within the time as set forth in the purchase order, instruction manuals and information in accordance with Section GW-2.9 of the General Works.
The Contractor shall also furnish the following information:

a. Outline drawings of transformer and accessories showing all critical dimensions and weights, including the following:

   1. Base mounting and transport dimensions;
   2. Bushing and cable box locations;
   3. High, low and tertiary voltage terminal arrangement;
   4. Control cabinet size and location;
   5. Connection points for all external connections;
   6. Conservator;

7. Nameplate connection plate and all other designation plate drawings.

b. Equipment layout, including mounting details, schematic and control circuit diagrams and drawings for the following:

1. Gas monitoring system for the transformer;
2. Oil filter units for the on-load tap changer;
3. Indoor Transformer Control and Operation System;
4. Outdoor tap-changing operating control cubicle and mechanism. The supply voltage and current required for operation of motor shall also be shown.

c. Layout, including mounting details, schematic and control circuit diagrams (alarm and trip) and drawings for all transformer relays;

d. Description and instructions covering the installation, operation and maintenance of the transformer and all accessories; drawings or cuts showing assembly of the accessories including, but not limited to:

1. Tap changer;
2. Inert gas or conservator systems;
3. Hot spot devices;
4. Temperature indicators;
5. Transformer relays;
6. Oil filter units (if required);
7. Gas monitoring system;
8. Temperature monitoring and recording system;
9. Fans and pump cooling control;
10. Silica gel breathers;
11. Transformer Blast and Fire Prevention System, if required;
12. Transformer Control and Operation System.

e. Assembly drawings for core and coils, including the location of ground strap and means of access for the core ground strap;

f. Dimensioned cross-sectional drawings of all bushing pockets showing flanges, current transformer pockets and all aluminum clearances;

g. Bushing drawings including terminal details, voltage rating, BIL, cantilever strength, minimum creepage distance, etc.;

h. Instrument transformer connection diagrams;

i. Detailed radiator drawings showing number, dimensions, spacing and configuration of radiator coolers; fan mounting details and foundation load if radiators are self-supporting;

j. Foundation outline for the transformer detailing the location and distances of anchor bolts, rails (if transformer is mounted on wheels);

k. Complete instructions for untanking the core and coils;

l. Earthing details;

m. Piping layout and diagrams;

n. The final design short circuit strength calculations including basic equations and references to the literature;

o. Certification from the Manufacturer of transformer that the transformer oil does not contain Polychlorinated Biphenyl (PCB);

p. Detailed QA Program based on ISO 9001 Certification;

q. ISO 9001 Certification of the proposed manufacturer;

r. Routine Test Results duly signed and witnessed by NPC's representative(s) if Factory Acceptance Tests are required to be witnessed by NPC's representative(s); and

s. Field Tests to be performed and test reports duly signed and witnessed by NPC's representative;

Schematic and connection diagrams for cooling and tap changer control equipment, including supply and control circuits. The supply voltage and current required for operation of motors shall also be shown.

EW-2.6.5 Diagram of Alarm Circuits

Description and instructions covering the installation, operation and maintenance of the transformer and all accessories; drawings or cuts showing assembly of the accessories including, but not limited to, the tap changer, inert gas or conservator systems, hot spot devices, temperature indicators, relays, and cooling control draining of oil.

Complete instructions for untanking the core and coils.

The sealed dry (drained of oil) shipped weight of the transformer.

A complete set of finally accepted drawings.

NPC's general review of drawings and information or waiver of same shall not in any way relieve the Contractor of any of responsibilities to meet all requirements of this specification or the NPC order.

EW-2.6.6 Certified Test Reports

The Contractor shall supply, at the time stated in the NPC order, the required quantity of certified copies of final test reports, including data and results of all tests required by this specification with respect to all values or relations specified herein or stated in the standards. This shall include copies of voltage and current oscillogram, with magnitude and time calibrations.

For transformers failing to meet the specified tests, a supplemental report shall be made prior to final acceptance of the transformer, describing the failures, method of detection, including evidence in oscillographic or photographic form and the corrective measures taken.

EW-3.0 POWER, CONTROL AND INSTRUMENTATION CABLES

EW-3.1 SCOPE

EW-3.1.1 General

This specification covers the technical and associated requirements of 600 V power, control and instrumentation cables, and medium voltage power cable for use in switchyards and substations.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. Contractor shall furnish high quality power and control cables meeting the requirements of these specification and industry standards.

Contractor shall bear full responsibility that the cables have been designed and fabricated in accordance with all codes, standards, and applicable governmental regulations and performs under the condition and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to the compliance with this specification without exception and/or if there are any exceptions, these shall be described in detail and included in the Contractor's proposal. The Contractor shall add a statement that no other exceptions are taken to this specification.

EW-3.1.2 Works to be Provided by the Contractor

The work to be provided by Contractor shall include, but not necessarily be limited to, supplying the cables and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-3.1.3 Works to be Provided by NPC

NPC shall provide the materials (if any) and services listed in Section B.1.0 of the Technical Data Sheets.

EW-3.2 CODES AND STANDARDS

EW-3.2.1 General

The cables to be furnished shall be manufactured in accordance with, but not limited to the latest issues of the following codes and standards including all addenda, in effect at time of purchase order unless otherwise stated in this specification.

ASTM	**American Society for Testing and Materials**
B3	Specification for Soft or Annealed Copper Wire
B8	Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B33	Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
B189	Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials
IEC	**International Electrotechnical Commission**
60028	International Standard of Resistance for Copper
60060	High Voltage Test Techniques
60093	Methods of Test for Volume Resistivity and Surface Resistivity of Solid Electrical Insulating Materials
60183	Guide to selection H.V. cables
60189	Low frequency cables and wires with PVC insulation
60227	Specification for Cables and Flexible Cords for Electric Power and Lighting
60228	Conductors of insulated cables
60229	Tests on Cable Over-Sheaths, which have a special protective function and are applied by extrusion
60230	Impulse test on cables and their accessories
60270	Partial Discharge Measurements
60287	Calculation of the current rating
60331	Fire Resistant Test
60332	Tests on Electric Cables Under Fire Conditions
60364	Continuous Transmission Capacity
60446	Color code for conductors
60502	Extruded solid dielectric insulated power cables for rated voltages from 1 to 30 kV
60538	Test methods for PE insulation and sheaths
60540	Test methods for elastomeric and thermoplastic compounds
60708	Low frequency cables with polyolefin insulation
60754	Halogen Content Test
60811	Common Test Methods for Insulating and Sheating Materials of Electric Cables
60885-2	Electrical Test Methods of Electric Cables Partial Discharge Tests
60949	Calculation of Thermally Permissible Short circuit currents, Taking into Account Non-adiabatic Heating Effects
60986	Guide to short circuit temperature limits of electric cables with a rated voltage from 1.8/3(3.6) kV to 18/30(36) kV
1034	Smoke emission tests
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing
NEC	**National Electrical Code**
PEC	**Philippine Electrical Code, Part I**

These codes and standards set forth minimum requirements which may be exceeded by Contractor if, in Contractor's judgment and with NPC's acceptance, superior or more economic designs or materials are available for successful and continuous operation of Contractor's equipment required by this specification.

EW-3.3 TECHNICAL REQUIREMENTS

EW-3.3.1 General

The cables shall be designed for trouble-free service for the highest system voltage.

All cables and their accessories to be supplied shall have insulation levels able to withstand any voltage surges which are normally expected to occur in the power system in which the cable is to be employed, due to switching operations, sudden load variations, faults etc.

All cables shall be selected to withstand without distress any short-circuit currents in the conductor and sheath related to the existing fault levels.

The cables and its accessories shall be constructed to fulfill the requirements when operating with full load or at any load factor.

The cable shall be suitable for use in ducts, trays and for direct burial in ground.

EW-3.3.2 Conductor

Copper conductors for power, control and instrumentation cables shall be concentric-lay-stranded, bare, or coated in accordance with ASTM B3, ASTM B8, or ASTM B33 or equivalent IEC Standards.

EW-3.3.3 Insulation

Insulation shall be of the type specified in the Technical Data Sheets. Insulation type shall be in accordance with National Electrical Code Designation or equivalent IEC Standards.

EW-3.3.4 Jacket

A tough, ozone, low chlorine, heat, flame and moisture-resistant PVC or HDPE jacket capable of providing protection against sunlight, acids, alkalis and oils shall be furnished for all cables. Jacket materials shall meet the requirements of applicable IEC Standards.

EW-3.3.5 Grounding Conductor

Copper grounding conductors shall be furnished within-multi-conductor 600 V power cables. Total cross-sectional area of the grounding conductors shall be in accordance with the National Electrical Code requirements or equivalent IEC Standards. Grounding conductors shall be bare.

EW-3.3.6 Assembly

All multi-conductor cables shall be bundled together with non-hygroscopic fillers to assure a smooth circular assembly. A lapped core binding tape shall be applied over the assembly.

EW-3.3.7 Technical Requirements for Control and Instrumentation Cable

For Instrumentation Cables, the following additional criteria shall apply:

Drain Wire

Class B, 7 strands, annealed, tinned copper drain wire (not less than two AWG sizes smaller than the insulated conductor but not smaller than 20 AWG), to be laid spirally with the same direction and lay as the twisted pair.

Shielding Tape

Type of shielding tape, if not specified in the Technical Data Sheets shall be a 100 percent coverage of a minimum of 2.0 mil Aluminum/polyester tape with metallic face of tape in continuous positive contact with the drain wire. Minimum overlap of shielding tape shall be not less than 20% of its width. The twisted pairs shall have their shields isolated from one another.

The semi conducting thermosetting compound screen layer shall be able to be peeled off easily, without leaving any residue on the insulation.

Cabling

Pairs are to be cabled with fillers, if required, and binder tape which are flame resistant and non-hygroscopic.

EW-3.3.8 Technical Requirements for Medium Voltage Power Cables

For medium voltage power cables, the following criteria, in addition to Section EW-3.3.1 thru EW-3.3.4 shall apply:

Strand Shield

Extruded layer of semiconducting thermosetting compound compatible with the insulation. It shall be continuous, with a minimum thickness of 0.5 mm, with no rough surfaces and keeping close contact with the insulation. The semi-conducting screen shall withstand the temperature in the conductor and the admissible mechanical forces in the insulation, and shall have no detrimental effect on the conductor or the insulation. The insulation semi-conducting screen shall be directly applied upon the insulation and shall make a perfect continuous and discharge free contact, with a minimum thickness of 0.1 mm.

Insulation Shield

Extruded layer of semiconducting thermosetting compound compatible with the insulation. Average thickness of the insulation shall be not less than the

nominal value specified in IPCEA or IEC 60502. The maximum thickness in any particular point shall not be greater than 25% of the nominal value specified.

Metal Tape

Annealed copper tape over insulation shielding per ICEA S-19-81, Paragraph 4.1.1.2, with a minimum overlap of 12%. The construction of the metallic screen shall guarantee a perfect contact with insulation semi-conducting screen to constitute an equipotential system. The dimensional characteristics shall be calculated in such a way as to ensure a permissible short circuit current specified in the Technical Data Sheets during 3 sec., without causing overheating in the close layers.

Oversheath or Outer Jacket

The oversheath shall consist of a compound applied by an extrusion process, adequate to the rated cable temperatures, if one of the following alternatives to be specified by the Contractor.

a. Sheath of polyvinyl chloride (PVC) colored black, with anti-termite repellant, non-poisoning type adequate for termite type "ODONTERMUS FORMASANUS" and "COPTERMES FRENCHI".

b. Black sheath of high density polyethylene (HPDE), with characteristics according to IEC 60811, ST4 type or equivalent IPCEA or ASTM Standards.

The nominal thickness shall be 0.3 mm and the maximum thickness in any particular point shall not be greater than 25% of the nominal value.

Maximum Conductor Temperature

The insulating material shall be able to withstand the maximum permissible temperature for conductor, as stated below:

Continuous	:	90°C
After short circuit	:	250°C

EW-3.3.9 Application

All cables shall be suitable for installation in cable tray (NEC type TC), conduit, trench, underground duct in wet and dry locations, and above ground raceway in damp and dry locations.

EW-3.3.10 Accessories

Each end of each cable shall be hermetically sealed with a heat shrinkable elastomeric cap fitting or other suitable means, to protect against the entrance of moisture.

EW-3.3.11 Cable and Cable Reel Marking

Cable shall be identified by surface printing of the jacket indicating: manufacturer, conductor metal (thermocouple cable only), size, insulation type, voltage rating, number of conductors, and sequential meter marker and date of manufacture.

Each cable reel shall be marked on both sides with indelible lettering as indicated in the Technical Data Sheets.

EW-3.3.12 Color Coding

All three conductor power cables shall be color coded in accordance with method 4 of the ICEA standard unless otherwise amended in the Technical Data Sheets.

All control cables shall be color coded in accordance with the K2 sequence as specified in the ICEA standard unless otherwise amended in the Technical Data Sheets.

Instrumentation cable shall have individual pairs colored Black/White. On multi pair construction, the pairs shall be numbered unless otherwise amended in the Technical Data Sheets.

For thermocouple extension cable type E the positive conductor (chromel) shall be purple, and the negative conductor (constantin) shall be red.

EW-3.4 INSTALLATION

Installation will be by Contractor, unless specified in Section B.1.0 of the Technical Data Sheets.

When the installation is by Contractor, such as for turnkey contracts complete details of proper handling, transport and storage, installation, testing, commissioning, performance guarantees, etc. shall be provided for NPC's review and approval.

EW-3.5 TESTS

EW-3.5.1 Factory (Production) Tests

EW-3.5.1.1 General

Cables shall be tested at the factory in accordance with applicable standards to determine their compliance with the requirements of this specification. Tests shall be conducted on samples and on the entire length of cables in accordance with the applicable standards.

The costs of all tests and test reports shall be borne by the Contractor.

EW-3.5.1.2 Design Tests

Cable and materials shall be subjected to the design (or type) tests, if specified in accordance with the test standards specified herein. Design test can be omitted if a design test record of the same cables can be submitted. In general, the following test shall be performed as a minimum:

a. Conductor Tests. Tests shall be performed on selected samples of the conductors before the application of any covering. These tests shall include as a minimum:

   1. Tensile strength test
   2. Elongation test
   3. Conductor resistivity test
   4. Dimension measurement
   5. Surface finish inspection
   6. Water and saline absorption test
   7. Shrinkage test
   8. Water penetration test

b. Physical and Aging Tests on the Cable, Insulation and Jacket. Tests shall be performed on selected samples of the cable insulation and jackets. These tests shall include as a minimum:

   1. Thickness measurement
   2. Tensile strength test
   3. Elongation test
   4. Aging test
   5. Head distortion test

EW-3.5.1.3 Routine Tests

As part of routine testing at least the following test and measurements shall be carried out as a minimum:

a. Checking of the conductor, insulation and oversheath dimensions

b. Conductor resistance measurements

c. Dielectric tests

Additionally, for the high voltage cables, the following tests shall also be performed:

a. Partial discharge test
b. Impulse voltage test 1.54 x BIL at +20 °C, each 3 negative and positive impulses (followed by power frequency test) on one sample of each cable type to be supplied.
c. Capacitance test
d. Insulation resistance test
e. Test on outer sheath (IEC 229)
f. Water penetration test

EW-3.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-3.6.1 General

Contractor furnished data and information shall be the guaranteed performance data, and construction features of all Contractors' furnished materials. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder. Any deviation from such data require NPC approval.

EW-3.6.2 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the filled-in Section B.3.0 of the Technical Data Sheets.

EW-3.6.3 Data and Information to be Submitted After Award of Contract

Contractor shall furnish the following information for each type of cable:

a. Brochures and catalogues to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment/materials being offered;

b. Complete description of technical characteristics of each type of cables;

c. Design (Type) Test Reports;

d. Cross-section and details of power, control, and instrumentation cables;

e. Cable rating calculations;

f. Make of each cable and cable reel;

g. Power, control and instrumentation cable routing plan;

h. Cable schedule, including cable numbers, identification, sizes, etc.;

i. Routine Tests Reports; and

j. Field Tests to be performed and Field Test Reports duly signed by NPC's representative(s).

The Contractor shall furnish in the manner, number of copies and within the time set forth in the contract, instruction manuals in accordance with Section GW-2.9 of the General Works.

EW-4.0 BUS CONDUCTORS AND HARDWARES

EW-4.1 SCOPE

EW-4.1.1 General

This specification covers the technical and associated requirements for stranded aluminum bus conductors and tubular aluminum bus conductors (if supplied) for use in electric power switchyards and substations.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. Contractor shall furnish high quality materials meeting the requirements of this specification and industry standards.

The Contractor shall bear full responsibility that the conductors and hardware have been designed and fabricated in accordance with all codes, standards and applicable governmental regulations and performs under the conditions and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exception, these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exceptions are taken to this specification.

EW-4.1.2 Works to be Provided by the Contractor

The Contractor shall provide the equipment, accessories and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-4.1.3 Works to be Provided by NPC

NPC shall provide the materials (if any) and services listed in Section B.1.0 of the Technical Data Sheets.

EW-4.2 CODES AND STANDARDS

EW-4.2.1 General

The conductors furnished shall be in accordance with, but not limited to, the latest issues of the following applicable standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification.

ASTM	American Society for Testing Materials
B230	Aluminum Wire, 1350-H19 for Electrical Purposes
B231	Aluminum Conductors, Concentric-Lay-Stranded
B232	Aluminum Conductors, Concentric-Lay-Stranded Steel Reinforced (ACSR)
B241	Aluminum Alloy Seamless Pipe External Tube

B341	Aluminum-Coated (Aluminized) Steel Core Wire for Aluminum Conductors, Steel Reinforced
B498	Zinc Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)
B549	Aluminum Conductor, Aluminum-Clad Steel Reinforced (ACSR0
E-139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
IEC	**International Electrotechnical Commission (all parts of listed Standards apply)**
60888	Zinc-Coated Steel Wires for Stranded Conductors
60889	Hard-Drawn Aluminum Wire for Overhead Lines
1089	Round Wire Concentric Lay Overhead Electrical Stranded Conductors
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing

These codes and standards set forth minimum requirements which may be exceeded by Contractor if, in Contractor's judgment and with NPC's acceptance, superior or more economic designs or materials are available for successful and continuous operation of Contractor's furnished conductors and hardware as required in this specification.

EW-4.3 TECHNICAL REQUIREMENTS

EW-4.3.1 General Requirements

General

The type(s) of conductor(s) to be furnished and their detailed characteristics are specified in the Technical Data Sheets. The standard design requirement for the basic conductor types are:

a. Stranded Conductors following ASTM Standards

ACSR/GB	ACSR conductor with outer layer(s) of hard-drawn aluminum wire type 1350-H19 per ASTM B230 and core layer(s) of Class B zinc-coated (galvanized) steel wires per ASTM B498, fabricated according to ASTM B232.
ACSR/AZ	ACSR conductor using aluminum coated (aluminized) steel core wire
ACSR/AW	Aluminum Conductor, Aluminum Clad Steel Reinforced fabricated according to ASTM B549
AAC/TAL	All aluminum conductors (Class AA) or thermally upgraded aluminum alloy fabricated according to ASTM

B231, Specification for Aluminum Conductors, Concentric-Lay-Stranded

TACSR Thermo-Resistant Aluminum Alloy Conductor Steel Reinforced

b. Stranded Conductors following IEC Standards

A1/SIB ACSR conductor with outer layer(s) of hard-drawn aluminum wire type A1 per IEC 60889 and core layer(s) of regular strength, class B zinc-coated steel wires per IEC 60888, fabricated to meet IEC 1089 requirements.

TAL High Conductivity Thermo-Resistant Aluminum Alloy Conductor

c. Tubular Conductor Following US Standards

6063-T6 Aluminum alloy extruded pipe fabricated to meet ASTM B241 requirements

EW-4.3.2 Manufacturing Requirements

Stranding for Conductor

All wires of the stranded conductor shall be concentrically stranded. The wires in each layer shall be evenly and closely stranded around the underlying wire(s). The tension in individual wires in a layer shall be sufficient to hold each wire firmly in place with only enough strand separation to prevent crowding at the time of stranding and during installation. All steel and aluminum wires shall lie naturally in their position in the stranded conductor and, when the core and/or the aluminum wires are cut, the wire ends shall remain in position or be readily replaced by hand and then remain approximately in position.

Conductor Characteristics

The aluminum shall be of the higher purity commercially obtainable which shall not be less than 99.5%. The Contractor shall submit certificate of analysis giving the percentage and nature of any impurities in the metal out of which the wires were made. There shall be no joints in the individual wires of the outer layer.

The type of conductor to be supplied shall be as stated in the Technical Data Sheets and shall be manufactured according to applicable ASTM or equivalent IEC Standards.

Tubular Bus (If required)

Bare aluminum tubular bus conductors shall be provided where indicated in the bid drawings.

The aluminum tube shall be made of 6063-T6, UNI 3569-T6 or Alcan 50 S-T6, first melting aluminum alloy ANSI Standard Schedule 40 standard pipe

size. This extruded seamless tubing shall be manufactured in accordance with ASTM Specification No. B241.

The electrical characteristics for the aluminum tube if applied for the substation shall be as indicated in the Technical Data Sheets.

The bus tubing shall be furnished with identification marking which shall include the following:

a. Manufacturer's Name

b. Specification Number

c. Alloy and temper

d. Size

Corona bells shall be furnished for the ends of all tubular buses.

Surface Condition

The completed conductor shall be smooth, free from nick, burrs, aluminum or steel particles, dirt and excessive die grease. The conductor shall be absolutely free of copper dust and copper particles. If so specified, the outer conductor surface shall receive an additional treatment to make it non-specular (non-reflective).

Conductor Hardware

Bus Support Clamps (For Tubular Bus)

a. All bus support clamps shall be cast of first melting aluminum alloy equivalent to 356-T6. Each clamp shall be adjustable for alignment with the insulator and furnished with four galvanized steel mounting bolts and lockwashers.

b. Bolted type bus support clamp, if used, shall be furnished complete with bolts, nuts and washers and shall be finished with anodic coating and lubricated. The clamps for tubing shall have dimensions and section suitable for splicing two pieces of tubing in the clamp.

c. Welded type non-expansion clamps shall be suitable for use either as a welded fixed clamp or as an unwelded slip clamp.

d. Flexible elements of expansion bus support clamps, where required, shall utilize a laminated aluminum strap which has current capacity equivalent to the tube. Expansion bus support clamps for 500 kV installation shall be furnished with corona rings to minimize corona.

Connectors

a. Connectors for aluminum shall be first melting cast aluminum alloy equivalent to 356-T6. All terminal pad drilling holes shall conform to NEMA CC1 and shall be furnished with stainless steel bolts, nuts, flat washers and belleville washers.

b. Bolted type connectors, if supplied, shall be a multi-grip type and furnished from first melting aluminum alloy equal to 356-T6 with bolts, nuts and washers and finished with anodic coating and lubricated.

c. Threads shall be coarse series, class 2A for bolts and class 2B for nuts.

d. Welded type connectors, if required shall be designed for filler welds or chamfered for butt welds.

e. All EHV terminal connectors for 500 kV shall be furnished with pad caps or shall be protected with corona rings or shields to prevent corona when bolting terminal connectors to flat pads. All terminal pad drilling holes shall conform to NEMA-CC1 and shall be furnished with stainless steel bolts, nuts, flat washers and belleville washers.

f. All terminal connectors shall have a smooth surface free from burrs and edges and fillet and shall be rounded to minimize corona concentration and radio interference. As much as possible, connectors shall be corona-free at highest voltage of equipment.

g. Angle and T-connectors shall be of streamlined, welded or bolted type as specified in the Technical Data Sheets and shall be made of first melting cast aluminum alloy 356-T6. Tap element sockets shall be deep enough to allow for error in cut-off.

h. The connectors shall be able to carry the continuous currents as specified for the conductors and equipment, without the constant temperature of the connectors exceeding the temperature of the weakest connecting point from the current carrying aspect. Connectors shall withstand the forces from the drawing conductors, vibrations and short-circuit.

i. The component for connection shall be adopted to the design size of conductor.

j. Couplers shall be of welded or bolted type as specified in the Technical Data Sheets and shall be made of first melting cast aluminum alloy 356-T6.

   For 500 kV, all couplers shall be of the internal fit, welded type to give maximum strength, streamlined appearance and minimum corona. This includes all straight and angle couplers and bus terminal connectors.

k. Corona bells shall be streamline internal type and cast from first melting aluminum alloy 356-T6.

All 500 kV corona bells shall be the bolted type for ease in expansion, future reuse and to eliminate possibilities of nicks and scratches.

Compression Connectors

a. Compression Dead End. The compression dead end, if used, shall be of tubular, compression type with non-adjustable clevis and made of first melting aluminum alloy equal to 1100 or Alcan D1S. They shall be designed to grip both steel core and the aluminum strands and must have an ultimate strength of the conductor specified in the Technical Data Sheets. Dead ends shall be equipped with galvanized steel clevis, bolts, nuts and stainless steel cotter pins with NEMA-CC1 tap pad.

Clamps

a. Aluminum Strain/Suspension Clamps. Aluminum strain clamps and suspension clamps for aluminum conductor, if required in the Technical Data Sheets, shall have its clamp bodies and keeper pieces, made of high strength and heat treated cast aluminum alloy. Cotter bolts, U-bolts, nuts, and lockwashers shall be hot dip galvanized steel. Cotter pins shall be made of stainless steel. Slip strength of the strain clamp shall be not less than 85% of the rated ultimate strength of the conductor.

b. Parallel Groove Clamp. The parallel groove clamp shall be made of aluminum alloy and be used for connecting the jumper conductor to the main conductor. The parallel groove clamp shall be bolted type and must be suitable for the specified conductor size and type. The slip strength of the clamp must not be less than fifteen percent (15%) of the ultimate breaking strength of the conductors being connected.

c. Wedge Pressure Clamps. Wedge pressure clamp if used, shall be of high strength aluminum alloy that is power driven between the run and the tap cable locking them into "C" shaped tampered aluminum spring body. The clamp shall maintain the pressure throughout the life of the connection to ensure reliability during severe electrical and climactic condition. The clamp shall provide superior contact integrity.

Conductor Spacer

a. Conductor spacer, when required by the number of conductor arrangement and ampacity ratings shall be furnished and shall consist of an interlinking body and clamps for gripping the conductors.

b. The spacer body frame shall be made of aluminum alloy and the clamps of the line spacers shall be hinged-type made also of aluminum alloy.

c. Clamp fastener shall be aluminum alloy break-away bolt.

d. The conductor spacer shall not be deformed due to electromagnetic attraction of short circuit current through the bundle conductors as specified in the Technical Data Sheets.

e. The corona noise from the conductor spacers shall not exceed that of the bundle conductors.

Galvanizing

All ferrous metal as described in this specification shall be galvanized by hot-dip process. The minimum quantity of zinc coating shall comply to the requirement of ASTM A153 and the degree of contamination specified in the Section B.1.0 of the Technical Data Sheets. Bolts and nuts shall be galvanized after being threaded and excessive zinc shall be removed, and the nuts shall run freely (by hand) over the entire length of the thread. The bolts and nuts shall not be re-tapped after galvanizing.

Finished materials shall be dipped into the solution of dichromate after galvanizing for white rust protection.

Oxide Inhibitor

When so specified in the Technical Data Sheets, the conductors and all aluminum connectors shall be protected by a high melting point (e.g. dropping point of approximately 380^0F), neutral, organic inhibitor.

EW-4.4 INSTALLATION

Installation will be by Contractor unless specified otherwise in Section B.1.0 of the Technical Data Sheets.

When the installation is by Contractor, such as for turnkey contracts complete details of proper handling, transport and storage, installation, testing, performance, guarantees, etc. shall be provided for NPC's review and approval.

EW-4.5 TESTS

EW-4.5.1 General

All materials shall comply with test criteria, and NPC's acceptance of the conductors and accessories shall not relieve the Contractor of his responsibility for meeting all the requirements of this specification.

The Contractor shall carry out his own expense all tests necessary to ensure the satisfactory design and manufacture of conductors in accordance with ASTM or equivalent IEC Standards.

Conductors, bus fittings, connectors and hardware shall be given the manufacturer's routine shop tests and quality conformance tests and shall be witnessed by the NPC or his authorized representative unless waived in writing. No conductors, bus fittings, connectors and hardware shall be shipped until released for shipment by the NPC of his authorized representative.

The Contractor shall make all preparation for tests and provide the test apparatus and personnel and shall notify the NPC the date of the tests to be witnessed forty-five (45) days in advance.

EW-4.5.2 Shop Tests

Cables and materials shall be subjected to the design (or Type) tests, if specified, and quality conformance (or Sample) tests in accordance with the test standards specified herein. Design tests can be omitted if a design test record of the same materials can be submitted. Even though NPC or his representative performs or witnesses the required tests and the cables and materials meet the acceptance criteria, Contractor shall not be relieved of the responsibility of providing cable conforming to all requirements of the specification.

In general, the following routine tests shall be performed as a minimum:

a. For Tubular Conductor (If supplied)

The tests shall be performed in accordance with ASTM B241. The routine test shall be performed by selecting the samples from each lot of equipment. The number of samples required for the test shall be 3 for each size;

1. General inspection
2. Dimension and weight measurement
3. Tensile strength and elongation test
4. Chemical composition or certified report of aluminum alloy from the original manufacturer
5. Surface finish inspection

b. For Stranded Conductors

The following tests shall be performed as a minimum in accordance with the applicable ASTM or equivalent IEC standards.

1. Construction test
2. Tensile strength test
3. Conductor sensitivity test
4. Dimension measurement
5. Surface finish inspection
6. Weight of conductor

c. For Bus Fittings

The tests shall be performed in accordance with NEMA CCI. The routine test shall be performed by selecting the samples from each lot of equipment. The number of samples required for the tests shall be: all for 1-3 sets; 3 for 4-30 sets; and 10% for over 30 sets.

1. General inspection
2. Dimension measurement

3. Chemical composition of aluminum alloy or certified report of the aluminum alloy characteristics from the original manufacturer

d. For Connectors

The tests shall be performed in accordance with the NEMA CC1. The routine test shall be performed by selecting the samples from each lot of equipment. The number of sample required for the tests shall be; all for 1-3 sets; 3 for 4-30 sets; and 10% for over 30 sets.

EW-4.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-4.6.1 General

Contractor-furnished data and information shall be the guaranteed performance data, predicted performance, interface requirements and installation/stringing features of all Contractor's furnished materials. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder. Any deviation from such data requires NPC approval.

EW-4.6.2 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the filled-in Section B.4.0 of the Technical Data Sheets.

EW-4.6.3 Data and Information to be Submitted After Award of Contract

The following shall be submitted before shipment of the bus conductors and hardware's:

a. Brochures and catalogues to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment /materials being offered;

b. Outline drawings indicating weight, dimensions, and material composition of hardware and conductors;

The Contractor shall furnish in the manner, number of copies and within the time set forth in the Contract, instruction manuals in accordance with Section GW-2.9 of the General Works.

EW-5.0 GROUNDING SYSTEM

EW-5.1 SCOPE

EW-5.1.1 General

This specification covers the technical and associated requirements for the grounding system of the supplied equipment, required to protect persons and equipment, to reduce electromagnetic interference (EMI) and to allow safe service and maintenance of the installations. The extent of the scope for the subject project (design and/or supply and/or installation) is specifically indicated in the Technical Data Sheets and Bid Drawing.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. The Contractor shall furnish high quality grounding system materials meeting the requirements of these specification and industry standards.

The Contractor shall bear full responsibility that the grounding system materials have been designed and fabricated in accordance with all codes and standards and that they perform under the conditions and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exception, these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exceptions are taken to this Specifications.

EW-5.1.2 Works to be Provided by the Contractor

The Contractor shall provide the grounding system materials, accessories and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-5.1.3 Works to be Provided by NPC

NPC shall provide the materials (if any) and services listed in Section B.1.0 of the Technical Data Sheets.

EW-5.2 CODES AND STANDARDS

EW-5.2.1 General

The materials and services of this specification shall be furnished in accordance with, but not limited to the latest issues of the following applicable codes and standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification:

For Grounding System Design:

IEEE Std. 80-1986 Guide for Safety in Substation Grounding

IEEE Publication 86 EH0253-5-PWR – Practical Applications of ANSI/IEEE Standard 80-1986, IEEE Guide for Safety

For Materials:

ASTM B3	Specification for Soft or Annealed Copper Wire
ASTM B8	Specification for Concentric-Lay, Stranded Copper Conductors
ASTM A474	Specification for Aluminum-Coated Steel Wire Strand
ASTM A475	Specification for Zinc-Coated Steel Wire Strand
ASTM A415	Specification for Hard-Drawn Aluminum-Clad Steel Wire
ASTM A416	Specification for Concentric-Lay, Stranded Aluminum-Clad Steel Conductors
ISO	International Standards Organization
9001	Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing

These codes and standards, as applicable to the specified material, equipment and services, set forth the minimum requirements which may be exceeded by Contractor if, in Contractor's judgement and with NPC's acceptance, superior or more economic designs and/or materials are available for successful maintenance and continuous operation of Contractor's grounding system as required by this specification.

EW-5.3 TECHNICAL REQUIREMENTS

EW-5.3.1 Description of Services

The materials, equipment and services covered by this specification are for use in one or more substation(s) and/or switchyard(s). Specific technical characteristics and requirements for the subject project are shown in Technical Data Sheets.

All materials and parts which are not specifically mentioned herein but are necessary for the safety of operating personnel and safe operation of the substation shall be furnished and determined by the Contractor at no increase in cost to the NPC.

The Contractor shall connect all metallic parts, such as structures, electrical equipment, cable trays, control boards, fences, metallic doors and fences, etc. within the substation area to the grounding system.

All connections of the earth grid to equipment at the grid end and the connection between the earth grid and earth rods shall be made by welding or pressure clamps.

Bolted connections will be permitted only above ground for connection to the fence or to equipment. All bolted connections shall be coated with corrosion inhibiting grease.

EW-5.3.2 Design Requirements

EW-5.3.2.1 General

The ruling criteria in the design of the grounding shall be the safety of personnel and the proper operation of the electrical equipment during normal operation and during transient disturbances such as short circuits in the electric power system and during lightning discharges.

All equipment such as power transformer, steel structures, etc., shall be connected to the existing grounding mat with adequate size of ground conductor as shown in the bid drawing. If there is no existing grounding mat, all equipment shall be grounded by means of ground rods.

EW-5.3.3 Equipment and Materials Requirements

EW-5.3.3.1 Grounding Cables

Grounding cables shall be copper conductor of soft drawn or hard drawn concentric stranding bare copper conductor in accordance with the latest revision of ASTM B3 and manufactured in accordance with ASTM Specification B8 (class B). The copper conductor shall have the characteristics specified in the Technical Data Sheets.

EW-5.3.3.2 Ground Rods

The ground rod shall be copper-covered steel of circular cross section, with a nominal diameter of 19 mm and a nominal length of 3 meters.

Each ground rod shall have a conical swaged point at one end and shall have a continuous smooth copper covering of at least 0.254 mm thickness molten-welded or copper bonded (electro-deposit) to a steel core. The copper clad or pressed type will not be accepted.

EW-5.3.3.3 Exothermic Welding Materials

The Contractor shall supply exothermic welding materials for cable-to-cable, cable-to-ground rod and cable-to-steel structure grounding connections. The Contractor should submit detailed information describing the proposed process.

EW-5.3.3.4 Grounding Hardware

Terminal Lugs

Terminal lugs shall be one hole, socket type, rounded edge lug, cast of high strength corrosion resistant copper alloy.

Machine screws, nuts, and washers used with the lugs shall be bronze.

EW-5.3.3.5 Steel Structure Grounding

Every steel structure that carries insulators or apparatuses shall be properly grounded.

If there is any possibility for a conductor to fall down on a steel structure, this structure must be connected to the grid with a connection able to sustain the earth fault current.

EW-5.3.3.6 Equipment Earthing

Transformer/Reactor Earthing

Power transformer/reactor tanks shall be earthed at two points diagonally opposite each other. These connections shall be made from two different points of the earthing grid.

Transformer/reactor earthing neutrals shall be earthed to two different points of the earthing grid. The transformer earthing strip shall be $\geq$ 100 mm^2 in copper.

Power Cables

The lead sheath or armor (shield) of the MV power cables, if to be provided, shall be earthed by connecting a flexible braid to the shield. This shall be done at both ends of each cable.

The copper wire shield of single-core MV power cables shall be earthed by connecting a flexible braid to the shield. This shall be done at both ends of each cable, if the cable is longer than 700 m, else arresters have to be installed.

Cable end boxes shall be earthed with copper cable connection on one of the mounting bolts.

Other Metal Structures

Other types of metal structures within the substation area, not mentioned hitherto, shall be connected to the earthing grid by copper ground conductor $\geq$35 mm^2 with one connection for each item. The only exception is radio antennas, the earthing of which follows other principles not stated herein.

Each metal-enclosed HV or MV equipment or compartment shall feature the connection of a readily installed short circuit device or special earthing bolts or screws allowing for application of earthing clips of approved design with flexible cables to be clamped into phase conductors by means of insulated earthing poles for subsequent earthing.

High voltage equipment shall be equipped with at least two terminal bolt M 16 in diameter or suitable grounding pads of adequate size to accommodate at least two fixing screws for proper connection to the earthing system.

EW-5.3.3.7 Ground Rods

Ground rods shall be driven to a depth such that the top of each rod is at the same elevation as the ground grid and shall be bonded to the ground grid conductors by suitable exothermic connections.

EW-5.3.4 Other Technical Requirements for the Grounding System

Other features for the grounding system if required by the NPC are stated in the Technical Data Sheets.

EW-5.4 INSTALLATION

Installation will be by Contractor, unless otherwise specified in Section B.1.0 of the Technical Data Sheets.

When the installation is by Contractor, such as for turnkey contracts complete details of proper handling, transport and storage, installation, testing, performance guarantees, etc. shall be provided for NPC's review and approval.

EW-5.5 TESTS

EW-5.5.1 General

The Contractor shall carry out at his own expense all tests necessary to ensure the satisfactory design and manufacture of all grounding equipment and materials in accordance with ASTM or equivalent IEC Standard.

EW-5.5.2 Design Tests

Cables, hardwares and materials shall be subjected to the design (or type) tests in accordance with applicable ASTM or equivalent IEC standards. Even though NPC or his representatives performs or witnesses the required tests and the cables, hardwares and materials meet the acceptance criteria, Contractor shall not be relieved of the responsibility of providing cables, hardwares and materials conforming to all the requirements of the specification.

EW-5.5.3 Quality Conformance and Routine Test

These tests are intended to eliminate defective materials and fittings. They are to be made on all materials and fittings of the type to which they are applicable, per applicable standards and/or per Contractor's quality assurance methods if accepted by NPC.

Grounding Cables

The tests shall be performed in accordance with ASTM B3 and ASTM B8 and shall include, but not limited to the following:

a. Tensile strength tests

b. Elongation tests

c. Conductor resistivity tests

d. Dimension measurement

e. Surface finish inspection

f. Weight of conductor

Grounding Materials

Quality conformance tests are required to verify the quality of materials and workmanship. They are to be made on fittings taken on random from the various lots offered for acceptance.

EW-5.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-5.6.1 General

Contractor furnished data and information shall be the performance data, predicted performance interface requirements and construction features of all Contractor's furnished equipment and materials. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder. Any deviation from such data requires NPC's approval.

EW-5.6.2 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the filled-in Section B.5.0 of the Technical Data Sheets.

EW-5.6.3 Data and Information to be Submitted After Award of Contract

The following shall be submitted by the Contractor as a minimum for NPC's review and approval:

a. Brochures and catalogues to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment /materials being offered;

b. Detail lists of grounding materials necessary for the equipment grounding;

c. Descriptive material brochures, drawings, instructions and other reference material for the specified grounding materials;

d. Detailed outline drawings of all grounding materials;

The Contractor shall furnish in the manner, number of copies and within the time set forth in the Contract, instruction manuals in accordance with Section GW-2.9 of the General Works.

EW-6.0 13.8 KV PROTECTION, MONITORING AND METERING

EW-6.1 SCOPE

EW-6.1.1 General

This specification covers the technical and associated requirements for the new protection, monitoring and metering of the 13.8 kV existing outdoor switchgear, complete with all accessories as hereafter specified and as shown on the attached drawings.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. The Contractor shall furnish high quality metal-clad switchgear and accessories meeting the requirements of these specification and industry standards.

The Contractor shall bear full responsibility that the equipment has been designed and fabricated in accordance with all codes, standards, and applicable governmental regulations and performs under the conditions and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exceptions, these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exemptions are taken to this specification.

EW-6.1.2 Works to be Provided by the Contractor

The work to be provided by Contractor shall include, but not necessarily be limited to, supplying the equipment and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-6.1.3 Works to be Provided by NPC

The assignment of responsibility of work to be performed by NPC is designated also in Section B.1.0 of the Technical Data Sheets.

EW-6.2 CODES AND STANDARDS

EW-6.2.1 General

The equipment/devices furnished shall be in accordance with, but not limited to, the latest issues of the following applicable standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification. These shall include:

ANSI/IEEE	**American National Standards Institute and/or Institute of Electrical & Electronic Engineers**
C12.1	Code for Electricity Metering

C37.2	Standard Electrical Power System Device Function Numbers
C37.90	Standard for Relays and Relay Systems Associated with Power Apparatus
C57.13	Standard Requirements for Instrument Transformers
C57.13.1	Guide for Field Testing of Relay Current Transformers
C57.13.3	Guide for the Grounding of Instrument Transformers
IEC	**International Electrotechnical Commission**
60044	Instrument Transformers
60145	Var-hour (reactive energy) meters
60211	Maximum demand indicators, class 1.0
60255	Electrical Relays
60258	Direct acting recording electrical measuring instruments and their accessories
60359	Expression of the Performance of Electrical and Electronic Measuring Equipment
60414	Safety requirements for indicating and recording electrical measuring instruments and their accessories
60521	Class 0.5 and 2 ac watt-hour meters
60625	An interface system for programmable measuring instruments
60687	Alternating current static watt-hour meters for active energy
1143	Electrical Measuring Instruments - x-t recorders
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing
UL	**Underwriters Laboratories, Inc. (all parts apply)**
44	Rubber-Insulated Wires and Cables

These codes and standards set forth minimum requirements which may be exceeded by Contractor if, in Contractor's judgment and with NPC's acceptance, superior or more economic designs or materials are available for successful and continuous operation of Contractor's equipment as required in this specification.

EW-6.3 TECHNICAL REQUIREMENTS

EW-6.3.1 Description of Services

The equipment/devices covered by this specification shall include all electrical features for the new protection, monitoring and metering of the existing 13.8 kV outdoor switchgear. The application details are in the Technical Data Sheets.

All materials and parts, which are not specifically mentioned herein but are necessary for the proper installation, assembly and safe operation of the monitoring and metering devices, shall be furnished at no increase in cost to the NPC.

EW-6.3.2 Design Requirements

EW-6.3.2.1 General

The new protection, monitoring and metering devices shall be supplied complete with all instrument transformers, auxiliary relays, terminal blocks, test terminals, wiring and miscellaneous devices as called for by this Specification or indicated in the Bid drawings. The contractor shall provide all required auxiliary and accessory devices whether or not expressly called for or indicated on the bid drawings. The contractor shall also modify the existing switchgear for proper interfacing of new protection, monitoring and metering devices.

A large number of cables will be brought in through the bottom of the existing switchgear panel and adequate provisions shall be made to accommodate, support and terminate these cables on the terminal blocks.

A basic single line diagram together with other layouts is included in the Bid Drawings issued with this Specification to give additional information on the extent, general locations and arrangement of the equipment.

The Contractor shall ensure that all equipment he supplies, functions correctly and safely.

The characteristics and ratings of the equipment and devices given in the applicable sections are not necessarily the standards of any particular manufacturer but they are the minimum requirements that must be satisfied by the Contractor.

The construction of the different parts of the Supply must be as standard as possible in order to reduce to a minimum the spare parts and to make the maintenance and replacement operation easy. All similar parts must be interchangeable.

EW-6.3.3 Feeder Protection

EW-6.3.3.1 General

The principle of the feeder protection system is shown in the single line diagram. It shall be a complete and integrated protection for the feeders of the existing 13.8 kV metal-clad switchgear.

The protection system shall employ modern microprocessor-based design preferably using numerical methods. Extensive self-checking and continuous monitoring function shall be provided to ensure security.

The relays shall be made insensitive to harmonics by use of proper filtering techniques.

Depending on the requirement specified in the Technical Data Sheet, the protection shall consist of phase and ground time and instantaneous overcurrent relays and reclosing relays.

Alarm and signaling facilities and a test switch at least for each group of relays for every feeder or for each individual relay shall be provided.

EW-6.3.3.2 Overcurrent Relay

The overcurrent relay shall consist of three phase units and a ground unit. Each unit shall have an instantaneous element and a time delayed element.

The overcurrent time delayed characteristics shall be programmable so that it shall be possible to field select definite time, IEC normal inverse, very inverse or extremely inverse characteristics or equivalent US moderately inverse, inverse, very inverse or extremely inverse characteristics for phase units independently and different from the ground relay.

Overcurrent relays shall include output contacts for tripping the associated breakers and for use in the substation alarms and event recorders.

Overcurrent relay setting ranges and parameters shall be as stated in the Technical Data Sheets.

The overcurrent relay, if required in the Technical Data Sheets, shall be provided with built-in fault and event recorder. It shall record all the analog voltage and current inputs as well as the operation of the output relays and the control inputs. The relay shall be able to store the last three fault records. The required software and other hardware needed to connect to a standard portable computer to access and analyze the recorded information shall be supplied.

EW-6.3.3.4 Reclosing Relay

When specified in the Bid Drawings and Technical Data Sheet, each feeder shall be provided with a reclosing relay which shall have a programmable auto-reclose sequence to be able to coordinate the instantaneous and time delayed characteristics of the feeder overcurrent relay with the downstream fuses and reclose on the protected circuit.

The autoreclosure unit shall receive its start commands from the instantaneous and time delayed units of the feeder overcurrent phase and ground relay. The starting signal determines whether a high speed or delayed reclosures and time delays required for each reclosure, until a final tripping is made. Consummation of the pre-defined autoreclosure program or sequence shall cause the relay to lockout until the reclaim time has elapsed.

It shall have at least three programmable reclosing shots (one high speed auto-reclose and one to two delayed auto-reclosures) with adjustable dead times specified in the Technical Data Sheets. A trip fail timer shall be provided which starts when the recloser is started and causes the relay to go into lockout if the start input stays on for the duration of the preset trip fail time. The relay shall also have a reset timer which allows the relay to reset from lockout after a successful manual close of the circuit breaker. The reset time

shall also be started after the final dead time following successful autoreclosing.

The reclosing relay shall be provided with at least the following inputs:

a. Enable or disable autorecloser from a switch
b. Breaker status via 52a or 52b contact
c. Start by overcurrent protection
d. Start by instantaneous protection
e. Cancel or block autoreclosing and the lockout relay
f. Reset the relay from lockout

The reclosing relay shall be provided with at least the following outputs:

a. Close circuit breaker
b. Autoreclosing in progress
c. Block Instantaneous Overcurrent trip
d. Circuit breaker failed to close
e. Recloser out of service

The recloser shall be provided with counters to count the number of successful first shots, second shots and third shots and the total number of unsuccessful shots.

Each feeder protection, if required in the Technical Data Sheets shall include a breaker failure protection function to provide a faster tripping of the main feeder. This function may be a separate unit or could be a built-in function of the overcurrent relay. The breaker fail function shall be initiated by any overcurrent trip to start a timer. When the breaker fails to open and isolate the fault, the breaker fail protection will trip the adjacent breakers after a preset time delay if the protective relay remains operated and also after checking that the current flowing through the breaker is still above a preset current level. If any of these conditions is not satisfied the breaker fail function resets and does not trip the backup breakers.

The protection system shall also provide protection for faults on the 69 kV bus that is fast enough to operate with 100ms. Schemes using the feeder relays or a separate differential relay to provide this protection will be acceptable. The tenderer shall provide details of the scheme offered.

EW-6.3.4 Watt-Hour Meters

Watt-hour meters shall be semi-flush mounted and front connected. The meter cases shall be dust-tight and moisture proof and shall fit into the existing switchboard in such a way as to permit reading without opening the corresponding front cover.

It shall be of the electronic metering module type with LED digital displays with limits of error according to IEC 60070.

The meters shall be suitable for continuous three-phase operation from the secondaries of current transformers and voltage transformers, with the ratio and connections indicated on the bid drawings or as required.

Meters for ungrounded systems shall be 2-element, 3-wire type with 2 current and 2 potential coils while meter for neutral grounded system shall be 3-element, 4-wire with 3 current and 3 potential coils.

Meters shall be equipped with a photoelectric 3-wire pulse initiator, which shall operate a polarized relay for multiplying the pulse initiator contacts to provide inputs to remote terminal units.

If wiring is provided between swinging panels, bundled conductors shall be used on the hinged doors or panels with extra/flexible wire, so arranged that a twisting rather than a bending motion is imparted to the moving bundled conductors. Each bundle shall be anchored such that the moving bundle length is the maximum available without loops.

Conductors within cubicles and between terminal blocks and apparatus shall be laid in plastic ducts or covered with plastic bands.

All power circuits, control and protection wiring and low level signal shall be physically separated. Separate laying-way shall be provided for power cables, and the working voltage of each power circuit shall be marked on the associated boards.

Conductor ends not connected to compression-type terminal blocks shall be provided with approved claw-washers, which neatly retain all strands, "Push-on" or "quick" type connectors shall be used for current transformers and trip circuits. These connectors maybe used for alarm and control system and within an equipment assembly only. Sample of any such connectors shall be submitted for NPC's approval.

Wiring shall be arranged to give easy access to the terminal or relays and other apparatus.

Soldered or wire strapped connections shall only be inside electronic systems. Any wire wrapping shall be in accordance with IEC Publication 60352.

As far as reasonably possible, all outgoing wiring shall be grouped by function (CT, VT, Trip, Alarm, etc.) with those going to a common destination allocated to adjacent terminal blocks. Terminal block configuration shall be submitted for NPC's approval. Labels shall be provided on the fixed portion of the terminal boards showing the function of the group.

EW-6.3.5 Digital Multifunction Meter

The supplied Digital Multifunction Meter shall be able to display the most critical measurements in the mains-power equipment: voltage, amperage, active power (watts) and power factor.

The Digital Multifunction Meter should have the following minimum required capabilities and features:

1. Current cumulative (kVAR),
2. Energy delivered/ received (kWh)

3. Reactive energy delivered (kVARh)
4. Instantaneous power (kW)
5. Maximum demand (kW)
6. Voltage (V)
7. Current (A)
8. Frequency
9. Power factor

EW-6.3.6 Instrument transformers

The instrument transformers shall be indoor type designed and rated in accordance with IEEE C57.13 or IEC 60044-2, "Requirements for Instrument Transformers".

Potential Transformers

Potential Transformers shall be indoor, plastic impregnated or butyl-molded type 14,400-120V voltage rating, 60 Hz, thermal rating of not less than 400 VA for a 30°C rise above 55°C ambient with basic insulation level of not less than 60 kV. Each transformer shall be equipped with the necessary mounting devices, fuse blocks and removable insulated, primary current limiting fuses. The fuses shall be able to withstand the maximum possible energizing current but shall interrupt the circuit in case of a short circuit on the secondaries of the potential transformers. The IEC/IEEE accuracy classification of all potential transformers shall be 0.5 or better or equivalent IEC Standard accuracy for relaying and metering. However, for revenue metering, accuracy class shall be 0.2.

Current Transformers

The current transformers shall have a standard insulation class of 15 kV and a basic insulation level of not less than 95 kV. The temperature rise of shall be limited to 30°C over a 55°C ambient. All current transformers shall have a polarity marks, with short-circuiting devices and nameplates.

The mechanical rating of all current transformers to be supplied shall be in accordance to IEC 60044-1. The IEC/IEEE relaying class at 60 Hz shall be at least 5P20 and metering accuracy class shall be 0.5 in accordance to IEC Standard for relaying and metering class. However, the revenue metering accuracy class shall be 0.2.

EW-6.3.7 Accessories

Terminal Blocks

Terminal blocks shall be mounted so as to give easy access to wires, terminations and ferrules and shall give a clear view of the arrangement of cable tails. The AC, DC current and voltage transformer inputs shall be separately grouped and adequately protected. Each wire shall be connected to an individual terminal which shall have a clearly lettered marking strip corresponding to the wiring diagram. To allow for extensions and alterations, approximately 25% extra terminals should be provided per terminal block.

Terminal blocks for control wiring shall be rated not less than 30 A, 600 V with barriers of the type approved by the NPC.

Isolation-type terminal blocks shall be provided for the auto-reclosing scheme isolation and for all external alarms on each panel. Isolation type terminal blocks for the sequence of events and transient fault recorder terminals shall also be provided. Shorting type of terminal blocks for current circuit isolation to transient fault recorder shall be provided.

Terminal blocks shall not have more than twelve positions per block, shall be rated 600 volts, 30 amperes, shall be one-piece type and shall have vinyl marking strips. They shall have terminal screws on both sides; box clamps or saddle clamp terminals are not acceptable. No live metal shall be exposed at the back of the terminal blocks.

Every terminal point shall have individual and complete identification identical to those on the wiring diagrams and shall be acceptable to the NPC. Terminals for NPC's external connections shall be arranged for consecutive connections of conductors within one cable. Only one external wire will be connected to each outgoing terminal point. Wires (usually three to five, including ground isolating jumpers) for a given current transformer or voltage transformer circuit shall be connected to a single terminal block; they shall not be split between two blocks.

Test Terminals

Test terminals of plug-in type shall be provided for each group of metering or indicating instruments connected to the same instrument transformer. In cases where indicating instruments or meters connected to the same current transformer secondaries are installed on separate assemblies, test blocks shall be provided on each assembly to permit calibration and checking. Sufficient test plugs shall be provided for each test block.

All test devices and test switches shall permit complete isolation of the associated device or devices from the instrument transformers and other external circuits, and shall permit means for testing the device or devices from an external source through the use of appropriate test plugs.

Current transformer secondary circuits shall not be open-circuited at any time during operation of the test devices and test switches or during insertion or removal of the test plugs.

EW-6.3.8 Panel/Cubicle Wiring

Wires shall be 600 V, stranded copper conductor with thermoplastic insulation, and shall comply with the requirements of ICEA Standard No. S-61-402. Minimum size shall be 2.0 sq., mm. or larger for control circuit except annunciator wire which shall be 1.2 sq. mm. or larger. Minimum test voltage shall be 2000 V at 60 Hz.

All wiring shall be neatly run and securely fixed in such a manner that wherever practicable, wiring can be easily checked against diagrams.

As far as possible, all circuits shall be run along the shortest path to their addresses but shall be run only in horizontal and vertical planes. Diagonal runs are not acceptable. However, the wire runs shall not block access for ready test or removal of any device without disturbing other devices.

If wiring is provided between swinging panels, bundled conductors shall be used on the hinged doors or panels with extra/flexible wire, so arranged that a twisting rather than a bending motion is imparted to the moving bundled conductors. Each bundle shall be anchored such that the moving bundle length is the maximum available without loops.

Conductors within cubicles and between terminal blocks and apparatus shall be laid in plastic ducts or covered with plastic bands.

All power circuits, control and protection wiring and low level signal shall be physically separated. Separate laying-way shall be provided for power cables, and the working voltage of each power circuit shall be marked on the associated boards.

Conductor ends not connected to compression-type terminal blocks shall be provided with approved claw-washers, which neatly retain all strands, "Push-on" or "quick" type connectors shall be used for current transformers and trip circuits. These connectors maybe used for alarm and control system and within an equipment assembly only. Sample of any such connectors shall be submitted for NPC's approval.

Wiring shall be arranged to give easy access to the terminal or relays and other apparatus.

Soldered or wire strapped connections shall only be inside electronic systems. Any wire wrapping shall be in accordance with IEC Publication 60352.

As far as reasonably possible, all outgoing wiring shall be grouped by function (CT, VT, Trip, Alarm, etc.) with those going to a common destination allocated to adjacent terminal blocks. Terminal block configuration shall be submitted for NPC's approval. Labels shall be provided on the fixed portion of the terminal boards showing the function of the group.

Connections for indicating instruments, and for the telecommunication circuits from transducers, or modem outputs, shall use individually shielded wire pairs. One (1) extra terminal per pair of terminals shall be provided to connect this shield to ground.

Wiring required to interconnect shipping sections shall be terminated on a terminal board in one section, to which the loose wires of the other section will be connected when the sections are assembled. All wiring from a section that must cross the shipping split shall be terminated in the last section of the split and the interconnecting wiring shall be arranged so that the wiring extends between the two adjacent compartments. The wiring shall be tagged, bundled, terminated and then pulled back into one of the section.

EW-6.3.9 Test Equipment and Accessories

The Contractor shall include the necessary test equipment, tools and other accessories for the testing and commissioning of the new protection, monitoring and metering devices aside from those mentioned in the Technical Data Sheets. Cost of these test equipment shall be included in the price of the protection, monitoring and metering system.

EW-6.4 TESTS

EW-6.4.1 Factory (Production) Tests

Protection, Monitoring and Metering devices shall be tested at the factory in accordance with applicable standards to determine their compliance with the requirements of this specification. Tests shall be conducted on samples in accordance with the applicable standards.

The costs of all tests and test reports shall be borne by the Contractor.

EW-6.5 INSTALLATION

Installation will be by Contractor unless specified otherwise in Section B.1.0 of the Technical Data Sheet.

When the installation is by Contractor, such as for turn-key contracts, complete details of proper handling, transport and storage, installation, testing, commissioning, performance guarantees, etc. shall be provided for NPC's review and approval.

EW-6.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-6.6.1 General

Contractor-furnished data and information shall be the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor's furnished equipment. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder.

EW-6.6.2 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the filled-in Section B.6.0 of the Technical Data Sheets.

EW-6.6.3 Data and Information to be Submitted after Award of Contract

The following items shall be submitted by the Contractor after award of contract:

a. Brochures and catalogues to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment/materials being offered;

b. Instruction, maintenance and operation manuals;

c. Terminal box and terminal blocks details and schematic diagram;

d. As-Built Wiring Diagram and List of Materials;

e. Detailed QA Program based on ISO 9001;

f. ISO 9001 Certification of the proposed manufacturer;

The Contractor shall furnish in the manner, number of copies and within the time set forth in the contract, instruction manuals in accordance with Section EW-2.9 of the General Works.

EW-7.0 STORAGE BATTERIES

EW-7.1 SCOPE

EW-7.1.1 General

This specification covers the technical and associated requirements for a storage battery or storage batteries for use in electric power generating stations, switchyard and substations.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. Contractor shall furnish a high-quality storage battery or batteries meeting the requirements of these specification and industry standards.

The Contractor shall bear the full responsibility that the equipment has been designed and fabricated in accordance with all codes, standards, and applicable governmental regulations and performs under the conditions and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exceptions, these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exceptions are taken to this specification.

EW-7.1.2 Works to be Provided by the Contractor

The Contractor shall provide the equipment, accessories and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-7.1.3 Works to be Provided by NPC

NPC shall provide the materials (if any) and services listed in Section B.1.0 of the Technical Data Sheets.

EW-7.2 CODES AND STANDARDS

EW-7.2.1 General

The equipment furnished shall be in accordance with, but not limited to, the latest issues of the following codes and standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification:

ANSI/IEEE	**American National Standards Institute and/or Institute of Electrical & Electronic Engineers**
C18.1	Specification for Dry Cells and Batteries
Z55.1	Gray Finishes for Industrial Apparatus and Equipment (NO. 61 Light Gray and No. 24 Dark Gray)

450	Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations
484	Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations
485	Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations
IEC	**International Electrotechnical Commission (all parts of listed Standards apply)**
60896	Stationary Lead Acid Batteries, General Requirements and methods of Test
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing
NEMA	**National Electrical Manufacturer's Association**
IB 1	Definitions for Lead Acid Storage Batteries
NEPA	**National Fire Protection Association**
70	National Electrical Code - Article No. 480
UL	**Underwriters Laboratories Incorporated**
486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors
UBC	Uniform Building Code of the International Conference of Building Officials, Section 2312 - Earthquake Regulations

These codes and standards set forth minimum requirements which may be exceeded by Contractor if, in Contractor's judgment and with NPC's acceptance, superior or more economic design or materials are available for successful and continuous operation of Contractor's equipment as required by this specification.

EW-7.3 TECHNICAL REQUIREMENTS

EW-7.3.1 Description of Services

The storage batteries covered by this specification will be used to supply dc power under continuous and emergency conditions for the dc power system listed in the Technical Data Sheets. The batteries shall be complete in all respects and shall be furnished with all required accessories.

All materials and parts which are not specifically mentioned herein but are necessary for proper erection, assembly and safe operation of the battery system shall be identified and furnished by the Contractor and included in the price for the battery system.

EW-7.3.2 Design Requirements

Service conditions under which each battery shall operate satisfactorily and deliver the specified capacity are listed in Technical Data Sheets.

The Contractor shall furnish batteries as described in the Technical Data Sheets. The batteries shall comply with Article 480 of NEPA 70.

The batteries are required to supply power in case of emergency, the various substation equipment and auxiliaries as shown in the bid drawings. The batteries must have sufficient AH capacity to supply power to this equipment including future extensions and/or additions to the substations at an hour discharge rate described in the Technical Data Sheets.

The batteries shall be fully charged and stabilized at the open circuit voltage just prior to the commencement of the duty cycle.

Each battery shall perform in accordance with the requirements of its respective duty cycle at any time including the end of its service life. In this context, end of service life is defined as the time at which the battery capacity is 80% of Contractor's initial rating.

De-rating factors for the specified service conditions shall be applied in addition to the aforementioned requirements.

The nominal system voltage for each battery is provided in the Technical Data Sheets. Each battery is for use in an ungrounded system unless otherwise noted in the Technical Data Sheets.

EW-7.3.3 Design and Construction Features

The cell jars shall be of transparent impact-resistant heavy-duty polypropylene (PP) material to allow check of electrolyte level through the cell wall.

High and low electrolyte level lines shall be permanently marked on all four sides of cell and/or multicell units.

Sediment space shall be adequate to permit unimpaired operation of the battery despite material accumulation throughout its guaranteed life. Cell design shall accommodate plate growth such that jar will not crack.

Cells shall be vented. The vent plugs shall form a tight seal within the vent opening and prevent electrolytic creepage or dust and foreign matter entrance. The vent plug shall be the explosion resistant type.

Plates shall be supported so that no undue stress is placed on the jar or cover during the life of the battery. Supports shall be bottom supports. Negative and

positive plates shall be matched. The life of the negative plate shall be equal to or greater than that of the positive plate. The plates shall be reinforced as needed to retain their shape and shall have the necessary conducting material to maintain low internal resistance to carry the current to or from all parts of the plate under all operating conditions. Separators shall be impervious to the chemical action within the cell. They shall provide proper spacing and insulation between the plates and permit free circulation of electrolyte.

The battery whether wet or dry charged shall be furnished complete with electrolyte. The specific gravity of the electrolyte in the lead-acid batteries at 25degree shall be as specified in the Technical Data Sheets.

The Contractor shall furnish connectors for connecting the cells and tiers of the battery. The connectors and bolts shall be designed for a temperature rise not exceeding 30degree above a rated ambient of 40 degrees when conducting a sustained one hour current equal to the battery one-hour discharge rate and continuous current equal to the battery discharge rate described in the Technical Data Sheets.

All current-carrying parts, such as terminal bolts, links and connections shall be adequately protected to a degree of protection of at least IP20 (IEC 60529 or equivalent ANSI/IEEE Standard) to prevent personnel from coming into contact with the battery system. However, provision shall be made for measuring the cell voltages without removing such protection.

The voltage drop of all connectors in series shall be not be more than one volt while carrying the one-hour discharge current.

Connectors shall meet the requirements of UL 486A.

Intercell connectors shall provide a sufficient spacing between cells for periodic cleaning of cell sidewalls to eliminate traces of acid spillage, etc. The inter-tier connections shall be properly insulated and the arrangement shall be subject to NPC's review.

The terminal cells shall be provided with connectors (essentially, terminal plates, and terminal lugs) for copper cables as specified in the Technical Data Sheets for the Storage Battery. Appropriate size of terminal lugs for the power cable and ground cable for battery rack shall be provided by the Contractor. Sample of terminal lugs shall be furnished for approval by the NPC.

Solid copper connectors, terminal plates, and terminal lugs shall be lead plated for lead-acid batteries.

To allow easy monitoring of the battery cells electrolyte, the Contractor shall furnish staggered design battery racks made of corrosion resistant steel, properly insulated and painted. They shall consist of no more than two (2) steps or as specified in the Technical Data Sheets. The staggered racks shall be complete with all necessary steel frames, fittings, rails and braces, plastic insulating channels, plastic spacers and hardwares. The paint shall resist the corrosive effects of the battery electrolyte. The racks shall be designed to

permit the mounting of the batteries as easy as possible. The design shall also consider the easy maintenance of the batteries.

Each rack shall have a grounding pad and a lead plated terminal lug suitable for ground cable specified in the Technical Data Sheets.

If rack are shipped knocked down, all parts shall be numbered or match-marked to facilitate field assembly.

EW-7.3.4 Accessories

The Contractor shall furnish and ship with each battery system any and all accessories which are essential for proper installation, operation and maintenance. The accessories shall include, but are not limited to the following:

a. Vent-plug-mounted hydrometer syringe
b. Portable hydrometer syringe
c. Vent-plug-mounted thermometer
d. Battery cell voltmeter with shunt load resistor (2 percent accuracy with +/-3volt scale)
e. Goggles
f. Plastic face shield
g. Acid proof gloves
h. Apron
i. Overshoes
j. A quantity of bicarbonate of soda

Contractor shall furnish, as part of the whole supply for the battery system, a wall mounted storage cabinet for the accessories

EW-7.3.5 Other Technical Requirements for the Battery System

Other technical features for the battery system, if required by the NPC are stated in the Technical Data Sheets.

EW-7.4 INSTALLATION

Installation will be by Contractor unless specified otherwise in Section B.1.0 of the Technical Data Sheets.

When the installation is by the Contractor, such as for turnkey contracts, complete details of proper handling, transport and storage, installation, testing, commissioning, performances guarantee, etc. shall be furnished for NPC's review and approval.

EW-7.5 TESTS

EW-7.5.1 Material Tests

All materials shall comply with test criteria, and NPC acceptance of the equipment shall not relieve Contractor of his responsibility for meeting all the requirements of this specification. The Contractor shall carry out at his own

expense all tests necessary to ensure the satisfactory design and manufacture of storage battery in accordance with ANSI/IEEE or IEC equivalent.

EW-7.5.2 Shop Test

The weight of each positive and negative plate shall be measured before assembly. The tolerance shall not exceed ± 1.0 percent.

Contractor shall designate the permanent pilot cell on the basis of the test results for each battery's permanent record. If the battery is shipped wet, it shall be the cell with the lowest specific gravity after the battery is installed but not yet charged. If the battery is shipped dry, it shall be the cell indicating the lowest voltage while on charge. In addition, approximately 10 percent of the battery's cells shall be selected at random as permanent sample cells.

The following production tests shall be performed for batteries to be shipped wet:

a. Cell voltage measurement. The tolerance shall not exceed ± 0.01 volts.

b. Electrolyte gravity measurement simultaneously with a. The tolerance shall not exceed ± 0.01.

c. Cell jar leakage test. The cell shall be pressurized with air and for one hour the pressure shall remain constant.

If the battery is shipped dry, the battery test shall be made at the factory. For this test, the Contractor shall produce 5 percent extra cells in the same production run as for the battery and perform the tests on the extra cells.

EW-7.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-7.6.1 General

Contractor furnished data and information shall be the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor's furnished equipment. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder. Any deviation from such data requires NPC's approval.

EW-7.6.2 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the filled-in Section B.7.0 of the Technical Data Sheets.

EW-7.6.3 Data and Information to be Submitted After Award of Contract

After award of the contract, the Contractor shall furnish drawings and data, in quality and quantity as specified herein and in purchase order, for NPC's review and acceptance as follows:

a. Brochures and catalogues to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment /materials being offered;

b. Installation drawings showing batteries, interconnections, rack outline, dimensions required for mounting, weight of rack and filled cells, and description of rack finish for each battery system;

c. Cell outline including connector and battery terminal details, electrolyte levels, weight of assembled cell, separate weights of electrolyte, plates and jar;

d. Type, catalogue designation and description of major components furnished by Contractor;

e. Battery arrangement;

f. Complete design calculations;

g. Discharge graph for assumed pre-defined emergency case;

h. Length of time batteries can be stored if shipped dry charged and/or charged wet. Also, Contractor's storage recommendations.

i. Recommendations for tests after delivery including field tests and performance;

j. Instructions covering installation, operation and maintenance;

k. ISO 9001 Certification of the proposed manufacturer;

l. Detailed QA Program based on ISO 9001 or 9002 Certification; and

m. Final Drawings as approved.

The Contractor shall provide in the manner, number of copies, and within the time set forth in the purchase order, Instruction Manuals in accordance with Section GW-2.9 of the General Works.

EW-8.0 BATTERY CHARGER

EW-8.1 SCOPE

EW-8.1.1 General

This specification covers the technical and associated requirements for constant potential battery chargers for use in non-nuclear electric power generating stations, switchyard and substations.

It is not NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. Contractor shall furnish a high-quality battery charger meeting the requirements of these specification and industry standards.

The Contractor shall bear the full responsibility that the equipment has been designed and fabricated in accordance with all codes, standards, and applicable governmental regulations and performs under the conditions and to the standards specified herein.

No departure shall be made from these specification and standards unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exceptions, these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exceptions are taken to this specification.

EW-81.2 Work to be Provided by the Contractor

The Contractor shall provide the equipment, accessories and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-8.1.3 Work to be Provided by NPC

NPC shall provide the materials (if any) and services listed in Section B.1.0 of the Technical Data Sheets.

EW-8.2 CODES AND STANDARDS

EW-8.2.1 General

The equipment furnished shall be in accordance with, but not limited to, the latest issues of the following codes and standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification:

ANSI/IEEE	**American National Standards Institute and/or Institute of Electrical & Electronic Engineers**
C2	National Electric Safety Codes
C34.2	Practices and Requirements for Semiconductor Power Rectifier
Z55.1	Gray Finishes for Industrial Apparatus and Equipment (No. 61 Light Gray and No. 24 Dark Gray)

AWS	**American Welding Society**
A2.4	Symbols for Welding and Non-Destructive Testing Including Brazing
IEC	**International Electrotechnical Commission (all parts of listed Standards apply)**
60255	Electrical Relays and Protection Equipment (All Parts)
ICBO	**International Conference of Building Officials**
UBC	Uniform Building Code, Section 2312, Earthquake Regulations
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/ Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing
NEMA	**National Electrical Manufacturer's Association**
ICS 6	Enclosures for Industrial Controls and Systems
PE 5	Constant Potential Type Electric Utility (Semi- conductor Static Converter) Battery Chargers
Pub'l. 250	Enclosure for Electric Equipment (1000 Volts Maximum)
SSPC	**Steel Structures Painting Council**
SP1	Solvent Cleaning
SP5	White Metal Blast Cleaning
SP6	Commercial Blast Cleaning
SP10	Near - White Blast Cleaning
PA1	Shop, Field and Maintenance Painting
PA2	Measurement of Dry Film Thickness with Magnetic Gauge
UL	**Underwriters Laboratories Incorporated**
44	Rubber Insulated Wires and Cables
PEC	**Philippine Electrical Code Part I & II**

These codes and standards set forth minimum requirements which may be exceeded by Contractor if, in Contractor's judgment and with NPC's acceptance, superior or more economic design or materials are available for successful and continuous operation of Contractor's equipment as required by this specification.

EW-8.3 TECHNICAL REQUIREMENTS

EW-8.3.1 Description of Services

The equipment covered by this specification will be used by an electric utility in a power plant, substation or switchyard for continuous battery floating, equalizing and recharging.

All materials and parts which are not specifically mentioned herein but are necessary for proper erection, assembly and safe operation of the battery charger shall be identified and furnished by the Contractor and included in the price for the battery charger.

EW-8.3.2 Design Requirements

Input to the battery charger shall be as described in the Technical Data Sheets. The Contractor is advised that the ac power system may be subjected to 200 percent voltage surges of microsecond order due to motor starting. Also ground faults on high resistance grounded systems may cause 260 percent voltage surges of milliseconds order. Finally, unfaulted phases may rise to line-to-line potential above ground for a time not exceeding seven days. The battery charger shall be designed to continue operation during these transient conditions. Output from the battery charger shall be as described in Technical Data Sheets.

The battery charger shall be of the automatically regulated type and shall be of the latest technology employing microprocessor-based control system of plug-in modules, without use of electronic tubes.

Automatic regulation shall consist of maintaining constant current for equalizing charge and constant voltage for float conditions.

The battery charger shall be self-contained with all accessories as specified herein and as otherwise required to assure proper operation and protection.

The charger shall be switched to the equalizing mode by an adjustable equalizing timer. The timer shall be manually or automatically activated as specified in the Technical Data Sheets and shall automatically return the charger to the floating mode at the end of the pre-selected equalizing period.

The charger output voltage shall be continuously adjustable in the floating and equalizing mode of operation with ranges of adjustment as specified in the Technical Data Sheets.

The steady state floating and equalizing voltage deviation shall not exceed $\pm$ 0.5 percent at any load from no load to full load with ac input power source voltage and frequency variations as specified in the Technical Data Sheets.

The input transformer shall be provided with two 2.5 percent taps above and below the rated voltage.

The charger shall be provided with a current limiting means. The chargers shall be capable of delivering the current limit continuously without damage.

Chargers are for ungrounded (dc output) operation unless otherwise stated in the Technical Data Sheets.

The charger shall be provided with an automatic discharging and charging device.

The charger shall be provided with an electronic control and microprocessor board.

For substation where microprocessor-based substation control (MBSC) system is required, the charger shall be provided with an interface board to allow all data available in the charger microprocessor to be transmitted to the MBSC system.

The charger shall be provided with earth-fault monitoring device and anti-condensation heater.

EW-8.3.3 Design and Construction Features

The supplied battery charger shall be housed in the existing battery charger panel. The contractor shall utilize and modify the existing battery charger panel to accommodate the space requirement of the new battery charger. The new battery charger shall be fully integrated, retrofitted, and interfaced to match the existing battery charger configuration settings. It shall be provided with adequate ventilation and means of easy access to the interior. Provisions shall be made to allow control and power cables to enter either from the top or bottom of the cabinet or as required in the Technical Data Sheets.

The charger/rectifier and its accessories and/or components shall be adaptable to the batteries with which they are associated.

All plug-in modules, power supply units, etc., shall be inspectable and removable from the front of the cabinet (hinged panel open) without requiring access to the rear of the cabinet.

Cooling shall be either by natural convection or by forced air cooling. Low velocity, permanently lubricated redundant fans and disposable filters shall be provided when forced air cooling system is used.

Relays, meters, switches, indicating lamps, etc., shall be clearly identified functionally by a black background and white multi-layer nameplate with rust-resistant steel, self-tapping screws. The inscription shall describe the function of the device and shall be subject to NPC's acceptance.

Instruments, adjustments and controls shall be operable from the front panel. Fuses, if used shall be accessible by opening front panels. Each instrument shall have one percent accuracy or better.

The same type of compression connectors shall be provided for termination of ac and dc cables described in the Technical Data Sheets.

Pushbuttons, when furnished, shall be heavy-duty type, oil tight type recessed or provided with shroud ring. Control fuses shall be 250 V cartridge type or type accepted to NPC.

Indicating lights shall be extra-long-life lamps.

Means shall be provided for quick and convenient access, preferably by hinged door or panel, to protective devices and control circuit disconnecting devices furnished.

EW-8.3.4 Sound Control

The NPC will review the sound level of equipment covered by this specification with respect to the permissible exposure limits for personnel as defined in applicable codes and regulations. Accordingly, the sound level measured at a distance of 152.40 cm (5 ft.) from the outline of the equipment shall not exceed the allowable limit specified in the Technical Data Sheets.

If Contractor expects the maximum sound level of the equipment to exceed the specified allowable limit at a distance of 152.40 cm (5 ft), the Contractor shall use acoustical treatment features, subject to NPC's review and acceptance, to achieve the sound control design objectives.

If the expected maximum sound level of the equipment exceeds the specified requirements, the following sound level data (both attenuated and unattenuated) at equipment design point and for at least two other operating conditions shall be provided:

a. Maximum sound pressure level as would be measured under "free field" conditions at a distance of five (5) ft from the outerline of equipment shown in decibels, on the "A" scale, at the octave band center frequencies ranging from 31.5 to 8000 Hz.

b. Calculated maximum sound power level of the equipment shown in decibels at octave band center frequencies ranging from 31.5 to 8000 Hz and referred to base of 10^{-12} watts.

EW-8.3.5 Panel/Cubicle Wiring

All wiring shall conform to the requirements of applicable ANSI and ICEA (IPCEA) standards and shall be stranded, tinned copper, flame retardant, high temperature insulated.

All wires for a given circuit, or maximum of twelve wires, shall be in one bundle to facilitate tracing for trouble-shooting or removal for changes.

Wiring shall be free of abrasions and tool marks, including no nicks or fraying from stripping of insulation.

Wiring shall also:

a. Have a minimum bending radius of 6.25 mm (¼ in)

b. Have sufficient surrounding space to avoid jamming near terminal blocks, or between terminal blocks and wireways

c. Be adequately supported to prevent sagging and breakage caused by vibration or shock in transit.

All wires within a panel or unit shall be continuous, that is: no splicing is permitted.

Wire shall be of adequate rating for the current to be carried.

All circuits shall use nothing smaller than 2.0 mm^2 (No. 14 AWG wire). On other circuits where maximum current does not exceed 5 amperes, 1.25 mm^2 (No. 16 AWG) wire may be used.

Wire size and insulation selection shall conform with the following: no overheating of the conductor itself or insulation damage to adjacent conductor shall occur when wires associated with dc and ac control circuits carry 20,000 amperes and 10,000 amperes root-mean-square symmetrical respectively, for 0.025 second.

Where cables must be carried across hinges to devices mounted on doors, extra flexible, ICEA (Insulated Cable Engineers Association) Class D stranding conductors or equivalent IEC Standards shall be used.

The wire bundle shall be carried between a clamp on the door and on one fixed portion of the board or cabinet. These shall be adjacent to the hinge and shall be between 300 mm to 600 mm (12 to 24 inches) apart, with the door fully open.

Clamps elsewhere shall be spaced uniformly at a distance approximately no greater than 24 inches apart.

Terminal boards shall be provided for all controls, instruments, annunciators, meters and relays requiring external cable connections.

Contractor's wiring shall be terminated on terminal boards or equipment with insulation-gripping insulated wire terminal lugs.

The tongue portion of the terminal lugs shall be flanged-spade indented-spade or ring type.

Ratchet-type tools shall be used in attaching lugs to wires, to avoid loose connections due to insufficient pressure while crimping.

Box-clamp or saddle-clamp terminals are not acceptable because of possible damage to wire ends. Relays and other devices sometimes provided with saddle clamps shall be procured without such clamps, or the clamps shall be

removed during panel assembly; ring-type lugs shall be used for panel wiring to these devices.
No solder or "push-on" or "quick" type terminals shall be used except:

a. Solder-type for pushbuttons, on indicating lights, when specified

b. Solder-type for plat resistors when specified

c. Push-on for indicating lights when specified

External connections will be via cable with 3.5 mm^2 (No. 12) or 1.25 mm^2 (No.16 AWG) stranded copper conductors, and lugs similar to those described above.

Terminals for external connections shall be arranged for consecutive connection of conductors within one cable. One external wire will be connected to each outgoing terminal point.

If accidental short circuiting of certain wires can result in malfunction of equipment, such as closing or tripping of a circuit breaker, these wires shall not be terminated on adjacent terminal block points.

Provision shall be made for conveniently testing the continuity of all control circuits in the field.

Wire markers shall be provided on both ends of each wire that is longer than 12 inches. The markers shall use indelible designations in accordance with Contractor's wiring diagrams.

Adequate space shall be provided on both sides of the terminal blocks, for connecting wires, and for wire markers. To allow for stripping and bending of incoming cables, terminal strips shall be located a minimum of 8 inches away from cable entrances at the top and/or bottom cabinets.

EW-8.3.6 Instrumentation and Controls

The chargers shall be equipped with the following protective and control devices:

a. Chargers shall be self-protected against high transient overvoltages in dc and ac control and power circuits. This protection shall be built into the equipment and no special external connections, configuration of leads or connections of any external equipment shall be required.

b. AC input thermal magnetic air circuit breaker (number of poles and interrupting capacity in accordance with system requirements).

c. DC output thermal magnetic air circuit breaker (2 poles having capacity to interrupt the associated dc system short circuit current at its terminals; and one auxiliary switch normally closed when the breaker is open for alarm).

d. Adjustable current limiting networks, which, in the event of heavy current demands on the chargers, shall limit the maximum output current to the maximum 2.5 hours force charge rate. For loads of less than maximum 2.5 hours force charge rate, the current limiting network shall have no effect upon the operation.

e. Protection against discharge of the battery into the battery chargers upon failure of the ac supply, with automatic resumption of preset charging rate when power is restored.

f. Loss of ac power relays (all three phases if a three-phase unit is specified).

g. Low dc voltage relay.

h. DC overvoltage relay.

i. Earth-fault monitoring

j. Any failure of the charger detected by any of these alarm or protective devices shall be indicated locally, either by LED's, relay targets or local annunciator and by a contact closure to a single element ("window") of remote annunciator. Where substation is controlled through MBSC, any failure and/or alarms shall be completely known or incorporated in the MBSC structure for the substation.

k. All alarm and protective relays contacts shall be rated 125 volts dc, 5-ampere make and carry and 1.1 ampere non-inductive interrupting duty (NEMA ICS 2 - 125 designation 600 minimum).

l. Forced air cooling system failure alarm shall be provided if such a cooling system is used.

The following devices shall be furnished and mounted on the instrument panel of the chargers:

a. MANUAL-AUTOMATIC change over switch

b. Required output and input meters and accessories

c. Required instrument/equipment for "equalizing charge" current setting, "float charge" voltage setting and to set the charger from "float charge" to "equalizing charge" for the required number of cells for the battery system both in "Manual" and "Automatic" position

d. an equalizing timer with a range of 0 to 24 hours. Timers specified as automatically activated upon restoration of ac supply voltage following the loss of ac input power.

e. serial interface port for connection with the MBSC of the substation, if substation control is by MBSC. The interface port to be provided shall be compatible with the required type of connection with the MBSC.

SECTION VI

PART II

TECHNICAL DATA SHEETS

PART II - TECHNICAL DATA SHEETS

EW - ELECTRICAL WORKS

TABLE OF CONTENTS

ANNEX A (TO BE SUBMITTED WITH THE BID PROPOSAL)

A.1.0 POWER TRANSFORMER

A.1.1 Technical Features and Requirements

		Contractor's Data
a.	Manufacturer	
b.	Type and Designation	
c.	Country of Origin	

A.1.2 Transformer Description

		NPC Requirement	Contractor's Data
a.	Number of phase	3-phase	
b.	Insulation	Mineral oil	
c.	Application	Substation transformer	
d.	Class	Outdoor	
e.	Continuous rated output capacity at 65°C max. temp. rise, MVA	10	
f.	Self-cooled rating (ONAN)	10	
g.	Percent overload, %	20%	
h.	Type of overload capability (specific cyclic or short time emergency loading)	According to IEC 60354 normal cyclic loading	
i.	Type	Two-winding Transformer	
j.	Winding connections		
	1. H-winding	Delta	
	2. X-winding	Wye, grounded	
k.	Insulation level:		
	Nominal operating voltage level for equipment		
	1. H-winding, kV	69	
	2. X-winding, kV	13.8	
	Rated Voltage for equipment:		
	1. H-winding, kV	72.5	
	2. X-winding, kV	15	
	3. H/X-winding, neutral terminal, kV	25/15	

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirement	Contractor's Data
l.	Basic Impulse Level:		
	1. H-winding, kV	350	
	2. X-winding, kV	110	
	3. H/X-winding, neutral terminal, kV	150/110	
m.	Exciting current at rated voltage and frequency and based on maximum MVA rating of high voltage winding not more than	1.5%	

A.1.3 Capitalized Cost for Transformer Losses

When comparing between tenders, the capitalized cost for transformer losses will be used:

1. No load loss at 100% of rated voltage on mid-tap, (NL-L)
   $ 4,500.00/kW
2. Load loss related to 85°C, (LL)
   $ 3,200.00/kW
3. Auxiliary Loss for Stage 1 Cooling, (AuxL1)
   $ 1,750.00/kW
4. Auxiliary Loss for Stage 2 Cooling, (AuxL2)
   $ 1,300.00/kW

In the bid evaluation, the figure listed above will be multiplied by its respective guaranteed loss value in kilowatts, and the resulting figures will be added to the bid price to give total evaluated price to bid comparison.

A.1.4 Transformer Guaranteed Losses

Transformer Guaranteed Losses at Rated MVA, frequency, voltage & temperature.

		Contractor's Data
a.	No-Load Losses, kW	
b.	Load Losses, kW	
c.	Stage 1 Cooling Losses, kW	
d.	Stage 2 Cooling Losses, kW	
e	Total Losses, kW (a+b+c+d)	

Name of Firm	Name & Signature of Representative	Designation

A.2.0 SUBSTATION PROTECTION SYSTEM

A.2.1 Technical Characteristics and Requirements

	Contractor's Data
a. Country of Origin	
1. Transformer Protective Relay	_____
2. Breaker Failure Relay	_____
3. Bus Protective Relay	_____
4. Feeder Protective Relay	_____
b. Manufacturers	
1. Transformer Protective Relay	_____
2. Breaker Failure Relay	_____
3. Bus Protective Relay	_____
4. Feeder Protective Relay	_____
c. Model No.	
1. Transformer Protective Relay	_____
2. Breaker Failure Relay	_____
3. Bus Protective Relay	_____
4. Feeder Protective Relay	_____
d. Power Requirements, DC supply	
1. Transformer Protective Relay	_____
2. Breaker Failure Relay	_____
3. Bus Protective Relay	_____
4. Feeder Protective Relay	_____
e. Heat Dissipation, BTU	
1. Transformer Protective Relay	_____
2. Breaker Failure Relay	_____
3. Bus Protective Relay	_____
4. Feeder Protective Relay	_____

Name of Firm	Name & Signature of Representative	Designation

A.2.2 Bus Protection Technical Features and Characteristics (69 kV Busbars) (Not Applicable)

	NPC Requirement	Contractor's Data
a. Construction	Micro-processor based design (numerical/digital)	
b. Operating Parameters		
1. Bus differential relay		
a. Function Time	≤ 13 ms	
b. Setting Range	10 – 200 V	
2. Lock-out relay		
a. Type	Manual reset	
b. Operating time, ms	≤ 9ms	
c. No. of contacts required	to be coordinated with no. of associated relays	
d. Trip coil voltage operating range	70-145 Vdc	
e. Contact ratings		
1. Continuous	20 A	
2. 1 min.	40 A	

A.2.3 Over Current Relays Operating Parameters and Technical Features (If required)

a. Construction	Micro-processor-based design (numerical/digital)	

Name of Firm | Name & Signature of Representative | Designation

ANNEX B (TO BE SUBMITTED DURING THE POST-QUALIFICATION)

B.1.0 GENERAL TECHNICAL REQUIREMENTS

B.1.1 Project Requirements

All standard accessories, including those not indicated in this Specification, shall be furnished.

The detailed work to be performed by NPC or Contractor for the Project shall be as follows:

	NPC	Contractor
Design & Engineering		X
Fabrication & Manufacture of Substation Equipment and its accessories per specification		X
Factory Tests (Design & Routine)	X [1]	X
Packing and Delivery to Port of Loading		X
Delivery from Port of Loading (FOB) to Port of Entry (CIF Port of Entry)		X
Loading/Unloading		X
Delivery from Port of Entry to Site		X
Unloading at Site or NPC Stockyard		X
Storage, Moving and Care of Goods		X
Checking All Parts (at Delivery Port or Site)		X
Unpacking (at Site)		X
Foundations		X
Foundation Piers		X
Interconnecting Shipping Sections		X
Tools for Installation and Testing		X
Installation		X
Tools for Maintenance		X
Spare Parts		X
Cable and Wire Connections		X
Cable Schedule		X
Oil Filling and Treatment of Oil (for transformers, reactors)		X

[1] *NPC representative(s) to witness Factory Routine Tests, if required in the Technical Data Sheets of every equipment.*

Name of Firm	Name & Signature of Representative	Designation

	NPC	Contractor
Field Testing (Pre-Commissioning) [2]	X [2]	X
Calibration of Instrument & Controls		X
Quality Assurance Control	X	X
Touch-up Paint		X
Commissioning [2]	X [2]	X

The services of a competent field service engineer or technician __is__ required under this contract
(is, is not)

B.1.2 Site Conditions and Environment

The expected environmental and meteorological conditions for the location of the equipment installation are as follows:

	Description	NPC Requirements
a.	Elevation above sea level	Not higher than 1000m
b.	Equipment location (indoor, outdoor)	Outdoor
c.	Ambient conditions at equipment location	
	1. Temperature range °C	0 – 40
	2. Relative humidity %	75 –95 non-condensing
d.	Maximum outdoor daily average temperature, °C	32
e.	Outdoor air conditions:	
	1. Tropical (Yes, No)	Yes
	2 Dust or Salt Laden (Yes, No)	Yes
f.	Degree of Contamination (specify light, medium, heavy, or very heavy per IEC Std.)	Very Heavy
g.	Maximum design wind velocity, kph	185 kph
h.	Required creepage distance, mm/kV (Based on max. phase to phase voltage)	31
i.	Flood level above equipment pedestal, mm	300
j.	Other outdoor abnormal conditions: (Yes, No)	
	1. hurricane (typhoon)	Yes
	Design for seismic load (Yes, No): If Yes, refer to Section EW-1.10 of the Technical Specifications	
a.	Acceleration Factor (horizontal)	Yes
	1. Seismic zone factor, Z	0.4G
	Equipment shall be shipped, prepared and protected for outdoor storage for period of: year	One (1)

[2] *NPC representative to approve procedures prepared by Contractor and witness every field testing and commissioning to be conducted for each of the substation equipment.*

Name of Firm	Name & Signature of Representative	Designation

B.1.3 Other General Requirements

Description	NPC Requirements
a. Latest Edition of **ANSI Standards** in original book bound form to be provided for the following equipment: [3]	
1. Power Transformer	Refer to **Codes and Standard** under Technical Specifications.
2. Protective Relays	--- ditto ---
3. Protective Relays	--- ditto ---
4. Grounding System	--- ditto ---

[3] *The cost of ANSI Standards to be supplied shall be included in the cost of each equipment.*

Name of Firm	Name & Signature of Representative	Designation

B.2.0 POWER TRANSFORMER

B.2.1 Technical Features and Requirements

	NPC Requirement	Contractor's Data
Angular displacement for three-phase transformers *(specify ANSI Std. or vector group symbol if IEC Std. is applied)*	ANSI Std. or IEC Std.	
Winding material shall be:		
a. H-winding	copper	
b. X-winding	copper	

B.2.2 Capacity Ratings

The maximum simultaneous continuous loading, in windings without exceeding the temperature rise limitations, under each cooling condition, shall be as follows:

a. Winding	H & X	
b. MVA Rating, per phase		
1. H-winding	10	
2. X-winding	10	
c. PF (lead/lag)	0.85 lag	
d. Type of cooling	OA	
e. Temperature Rise top oil, °C/Average Winding Temperature, °C	65/65	

B.2.3 Impedance

a. Impedance (Percent/MVA Base) at 85°C		
1. H-X winding at 5 MVA	Manufacturer's Data	

B.2.4 Audible Sound

a. Average audio sound level not more than, dB	≤ 70	
with excitation of	100%	

Name of Firm	Name & Signature of Representative	Designation

B.2.5 Bushings

The Contractor shall provide bushings as follows:

		NPC Requirement	Contractor's Data
a.	Bushing class and standard:		
	HV terminals (H):		
	1. Rated current, A	To match MVA rating plus overload	
	2. Insulation Class	72.5	
	3. BIL in kV	350	
	4. Creepage length, mm	2248	
	LV terminals (X):		
	1. Rated current, A	To match MVA rating plus overload	
	2. Insulation Class	15	
	3. BIL in kV	110	
	4. Creepage length, mm	≥ 465	
	LV neutral terminal, (X_o)		
	1. Rated current, A	same as for LV (X) terminal	
	2. Insulation Class	15	
	3. BIL in kV	110	
	4. Creepage length, mm	≥ 465	
b.	Provision for potential taps on the condenser bushings H-terminal bushings	To be provided	
c.	Provision for test taps on the condenser bushings H-terminal bushings	To be provided	
d.	Terminal connectors shall be provided as listed below. Each terminal shall have a maximum RIV level of 10 microvolts when energized at 125 percent of the rating of the associated winding.		

Terminal	Description of Connector	
(H)	Manufacturer's std.	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
(X)	Manufacturer's std.	
(H_oX_o)	Manufacturer's std.	

B.2.6 Temperature Indicator

	NPC Requirement	Contractor's Data
a. Supply of dial-type winding temperature indicators mounted on the transformer for top oil and hot spot temperatures mounted side by side with each other approximately 1500 mm above ground level	To be provided	
b. Monitoring Equipment for Remote Temperature Indication shall be provided *(Yes, No)*	To be provided [4]	
1. Type	Microprocessor based	
2. Resistance Coil Hot Spot Temperature Indicator *(Specify quantity/phase)*	1/phase	
3. Transfer Switch	To be provided	
4. Instrument for Panel Mounting (size)	19" rack	
5. Required points for remote digital temperature recorder	2	
c. Equipment for Data Logging [5]	To be provided	
1. Number or Number Per Phase	1/phase	
2. Type:	Resistance Temperature Detector	

B.2.7 Sudden Pressure Relay

	NPC Requirement	Contractor's Data
a. Sudden pressure relay	To be provided	
b. Type	Manufacturer's Data	
Sudden Pressure Relay alarm/ trip of the Transformers shall be integrated in the:	Main Control Switchboard	

[4] *Can be installed in the same rack for Transformer Operation Control System.*
[5] *These functions shall be integrated in the Transformer monitoring and control system.*

Name of Firm	Name & Signature of Representative	Designation

B.2.8 Annunciator

	NPC Requirement	Contractor's Data
a. Annunciator in the remote transformer control cubicle	To be provided	

B.2.9 Transformer Taps

a. The taps specified in B.2.10 shall be full capacity taps and shall be connected as described therein.		
1. The taps, upon which all ratings shall be based, shall be for the: High Voltage Winding, kV	69 ± 10% at 0.625% steps for the on-load tap changer	
2. The transformer shall be shipped with a: *(specify on-load, no-load)* tap changers set at these taps	on-load	

B.2.10 Tap Changer

a. On-Load Tap Changing Mechanism		
1. A load tap changing mechanism for the transformer:	To be provided	
2. Taps above rating shall be *(percent steps/number)*	0.625% / 16	
3. Taps below rating shall be *(percent steps/number)*	0.625% / 16	
4. Operation and Control	Remote	
5. Tap changer rated current, A	By Contractor	
6. Power supply for motor, V	By Contractor	
7. Power requirement, motor, kW	By Contractor	
8. Degree of protection of transformer control system panel	IP 44	
b. Protective relay (oil-flow operated) and a sudden-pressure operated protection relay with trip contact for the conservator of LTC	To be provided	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
c. All tap changer functions, including tap changer position sensing, selection and display of "Auto-Manual" mode, oil-flow and sudden pressure operated relays (analog output=4-20 mA) shall be integrated in the Transformer monitoring and control system and MBSC	Yes	

B.2.11 Bushing Current Transformer and Potential Devices

a. Bushing current transformers with multi-ratios shall be supplied at the following terminals:	H & X (where applicable) & neutral	
b. Rated primary current, A:		
1. H-bushing	600	
2. X-bushing	600	
3. Neutral	To be based on the design requirements of the protection system by the supplier	
c. Rated secondary current, A:		
1. H-bushing	1 A	
2. X-bushing	1 A	
3. Neutral	1 A	
d. No. of Cores:		
1. H-bushing	2	
2. X-bushing	2	
3. Neutral	1	
e. Core Assignment:		
1. H-bushing:		
Core 1	Metering	
Core 2	Relaying	
2. X-bushing:		
Core 1	Metering	
Core 2	Relaying	
3. Neutral bushing:		
Core 1	Relaying	
f. Accuracy class:		
1. Metering Core	0.2	
2. Relaying cores	0.2	

Name of Firm	Name & Signature of Representative	Designation

B.2.12 Auxiliary Power Supply

	NPC Requirement	Contractor's Data
a. 230 VAC		
1. No. of phase	1-phase	
2. No. of wire	2-wire	
3. Frequency, Hz	60	
4. Short Circuit Capability, kA	50	
5. System	Ungrounded	
6. No. of set	1	
b. DC supply voltage		
1. Voltage	125	
2. No. of set	1	
3. Short Circuit Capability, kA	25	
4. System	Ungrounded	

B.2.13 Oil Preservation System

a. The conservator type of oil preservation system of the transformer shall be of the: *(specify diaphragm, nitrogen gas sealed, etc.)*	Diaphragm	
b. A single-float Buchholz relay each main conservator connected as leakage detector for the diaphragm of the air-bag type	To be provided	
c. A non-return valve with trip contact and automatic closing action for each main conservator, isolating the conservator when back-flow to the transformer corresponding to the breathing action is exceeded	To be provided	

B.2.14 Insulating Oil

a. Insulating oil shall be mineral oil in accordance with ASTM D3487 *(Type I, Type II)*	Per Manufacturer recommendation	
b. Mineral oil shall be Polychlorinated Biphenyl (PCB) free	Yes	
c. Additional Properties:		
1. Min. Flash Point, °C (ASTM D92)	145	
2. Pour Point, max. °C (not higher than)	-40	
3. Kinematic, Viscosity at 40°C	Max 12	

Name of Firm	Name & Signature of Representative	Designation

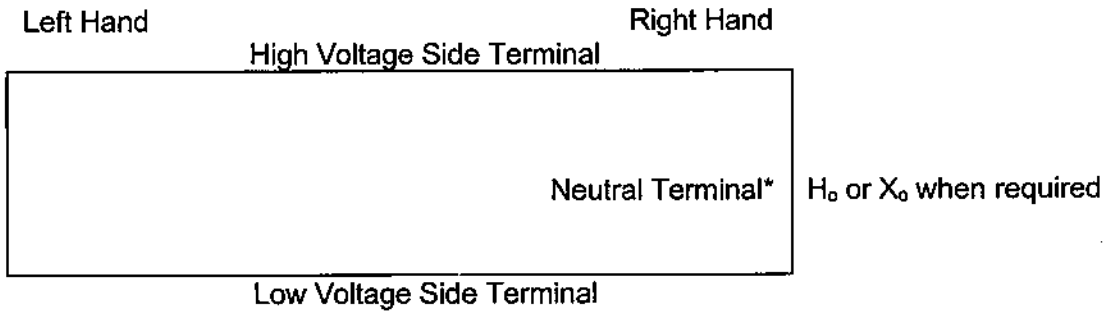
	NPC Requirement	Contractor's Data
4. Elect. Breakdown limit (IEC 60156 Sphe. Electr.)	Min 30	

B.2.15 The following shall be provided to facilitate handling the transformer:

a. Standard Skid Base of Heavy Steel 1. Without Wheels	Yes	

B.2.16 Bushing Location

The location of the bushings of the transformer shall be as shown below:



Note: Location of the neutral terminal are tentative. Final arrangement shall depend on the final layout of the substation and the substation equipment.

B.2.17 Oil Filter Units

a. Oil Filter Units for each OLTC tank	To be provided	
b. Type	Outdoor stationary type mounted on transformer tank	
c. Filter Accuracy	10 mm or better	
d. Residual water content in oil after filter	Less than 10 ppm	

Name of Firm	Name & Signature of Representative	Designation

B.2.18 Tests and Experience Requirements

B.2.18.1 Normal Tests

		NPC Requirement	Contractor's Data
a.	Is transformer design new or of previous design with the same rating and voltage level?	By Contractor	
	1. If new, design (type) tests and reports are required	Yes	
	2. If previous design of same rating and voltage, certified type test reports of duplicate production type are acceptable	Yes	
b.	Routine tests on all the transformers whether new or of previous design	To be performed	
c.	Certified Routine test reports	Yes	
d.	Additional tests are required *(Yes/No)*. If Yes, see B.2.18.2	Yes	
e.	Test reports of licenser instead of his own (Contractor) is:	not acceptable	
f.	Test frequency requirement (Power)	60 Hz	
g.	Factory Acceptance Tests (Routine) to be witnessed by NPC representative	Yes	
h.	Required no. of personnel to witness Factory Acceptance Tests	Three (3)	

B.2.18.2 Additional Tests

If additional tests are required (see B.2.18.1.d), they shall be as follows:

a. All the special tests mentioned in IEC 60076-1 Sub-clause 10.3 except for the short circuit withstand test.
b. One-hour low frequency induced dielectric tests which is required on all terminals.

B.2.18.3 Equipment and Manufacturer's Experience

a.	The manufacturer should have been in the business of manufacturing power transformer of the same voltage level or greater for not less than: years	10	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
b. The manufacturer must have a reference overseas (outside country of origin) supply record of the type of power transformer being offered: units	20	
c. The reference power transformers being offered at least from three (3) different power utilities at tropical countries or countries having the same climatic conditions as that of the Phils. should have been in the actual service and operating satisfactorily for not less than: years	3	

Note: Experience less than what is required will be ground for rejection of bids offered. Proof of satisfactory performance from at least three (3) different power utilities shall be submitted as compliance with the requirements and for NPC reference. Non-submission of the requirement shall also be considered as a disqualification of the bid being offered.

B.2.19 Auxiliary Power Supply

The items listed below shall be designed to receive the following voltage source:

a. Space heaters for the transformer control cubicle, Vac	230 Vac, 1- ϕ, 60 Hz	
b. Internal lights and convenience outlets	230 Vac, 1- ϕ, 60 Hz	
c. Motors	230 Vac, 1 -ϕ, 60 Hz	
d. Annunciator source	125 Vdc, +10%, -15%	
e. Indicating lights for position indicator of operating mechanism	125 Vdc, +10%, -15%	

B.2.20 Spares and Spare Parts

The following spares and spare parts aside from those Contractor's recommended spare parts shall be furnished for the transformer for **Roxas Substation.**

a. Bushings for the high voltage terminals complete w/ gaskets and oil, if oil-filled:		
"H" terminals	1 unit	
"X" terminals	1 unit	
"Xo" terminals	1 unit	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
b. Set(s) of gauges and thermometers of each type used	N/A	
c. Set(s) of gaskets for cover, manhole, hand-holes and piping connections	1	
d. Buchholz, single-float Buchholz, sudden pressure and winding temperature relay of each type used	1	
e. Amount of silica gel in container (25 kg) enough to refill the dehydrating breaker	1 can	
f. Transformer Main Tank Rupture Disk Bursting set.	N/A	
g. OLTC Rupture Disk Bursting Set	N/A	

All spare parts subject to damage or deterioration by moisture shall be packed in moisture-proof material. All spare parts shall be interchangeable with and identical in all respect to the original parts.

All transformer of one size and type and all transformer components of the same rating shall be fully interchangeable.

B.2.21 Tools and Appliances

In addition to those tools and appliances recommended by the Contractor for the transformer, the following tools and appliances shall be supplied for the transformer of **Roxas Substation.**

a. Manually operated jacks of ample capacity for lifting the transformer to place or position steel rollers during installation at job site (number of set/s)	1 set (4 units)	
b. Set of any special tools, wrenches and equipment that may be necessary or convenient for assembling/ disassembling the transformer (number of set/s)	1	
c. Set of slings enough to lift 105% of the transport weight of the transformer	1 set	

Name of Firm	Name & Signature of Representative	Designation

B.2.22 Other Technical Data to be Filled-in by Contractor

The Contractor furnished data and information are included in this Specification to indicate the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor furnished equipment. The accuracy of such information and the compatibility of such information with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

B.2.23 Other Technical Data by Contractor

	Contractor's Data
a. Manufacturer	
1. Transformer	
Type and Designation	_____
Country of Origin	_____
2. Bushings	
a) H-Terminal	
Type and Designation	_____
Country of Origin	_____
b) X-Terminal	
Type and Designation	_____
Country of Origin	_____
c) Y-Terminal	
Type and Designation	_____
Country of Origin	_____
d) Neutral	
Type and Designation	_____
Country of Origin	_____
3. On-Load Tap Changer	
Type and Designation	_____
Country of Origin	_____
4. Transformer Control System	_____
b. Winding Construction	_____
	(layer, disc, etc.)
1. Volts per turn, V	
a. H	_____
b. X	_____
c. Y	_____
c. Core Construction	_____
	(core, shell)
1. Area per limb, cm^2	_____

Name of Firm	Name & Signature of Representative	Designation

	Contractor's Data
d. Exciting Current	
1. at rated voltage	
2. at 100% voltage	
e. Resistance per phase, ohm	
1. H-winding	
2. X-winding	
3. Y-winding	
f. Winding Distributed Capacitance per Phase (microfarad)	
1. Winding to Ground	
a. H	
b. X	
c. Y	
2. Between Winding	
a. H-X	
b. H-Y	
c. X-Y	
g. Bushing Capacitance (stud to tap/tap to flange), pf	
a. H	
b. X	
c. Y	
d. Z	
h. CT Capacitance to Ground, pf	
i. Estimated Natural Resonant Frequency	
j. Cooling Power Required	
1. First step cooling, kW	
2. Second step cooling, kW	
k. Coolers	
1. Quantity	
2. Surface area, each (cm^2)	
3. Winding Hot Spot Temperature Setting, °C	
a. High Temperature Alarm	
b. High Temperature Trip	
c. First Step Cooling (ON)	
d. Second Step Cooling (ON)	
l. Fans	
1. Type	
2. Quantity	
3. Motor size, hp	
4. Motor speed, rpm	
5. Capacity, cfm	

Name of Firm	Name & Signature of Representative	Designation

	Contractor's Data
6. Locked rotor, A	
7. Normal load, kW	
m. Pumps	
1. Type	
2. Quantity	
3. Motor size, hp	
4. Motor speed, rpm	
5. Capacity, cfm	
6. Locked rotor, A	
7. Normal load, kW	
n. Weights	
1. Weight of core, kg	
2. Weight of winding, kg (total)	
3. Untanking weight, kg	
4. Oil-weight	
5. Total weight with oil, kg	
o. Dimension	
1. Completely assembled	
a) Overall height, mm	
b) Height over tank, mm	
c) Untanking weight, mm	
2. Dimension (accessories removed)	
a) Overall height, mm	
b) Height over tank, mm	
c) Untanking weight, mm	

Name of Firm	Name & Signature of Representative	Designation

B.3.0 POWER/CONTROL/INSTRUMENTATION CABLES

B.3.1 Technical Characteristics and Requirements

	Contractor's Data
a. Manufacturer	
1. Power, Control and Instrumentation Cable	
b. Country of Origin	
1. Power, Control and Instrumentation Cable	

B.3.2 600V Power Cable (If Applicable)

	NPC Requirements	Contractor's Data
a. No. of Conductors/Cable and Size [6]	By Contractor	
b. Conductor material	Tin Annealed copper stranded wire	
c. Conductor shape	Circular	
d. Conductor cross-section, (mm^2) [7]	Manufacturer's data	
e. Maximum outside diameter, (mm)	Manufacturer's data	
f. Type of insulation	PVC	
g. Thickness of insulation	Manufacturer's standard	
h. Type of jacket (cable sheath)	PVC jacketed for all cables	
i. Thickness of jacket (cable sheath)	Manufacturer's standard	
j. Maximum operating temperature, °C	90	

B.3.3 600V Control and Instrumentation Cable

a. No. of Conductors/Cable and Size	By Contractor	
b. Conductor material	Tin Annealed copper stranded wire	
c. Conductor shape	Circular	
d. Conductor cross-section, (mm^2)	Manufacturer's data	

[6] *Contractor to give full description of various number of conductor/cable, sizes and ampacities.*
[7] *Contractor to fill-up the required data.*

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirements	Contractor's Data
e.	Maximum outside diameter, (mm)	Manufacturer's data	
f.	Type of insulation	PVC	
g.	Thickness of insulation, not less than, (mm^2) [22]	Manufacturer's standard	
h.	Type of jacket	PVC jacketed for all cables	
i.	Thickness of jacket/outer sheath, not less than, (mm)	1.8 for all cables	
j.	Provided with filler and binder tape	Yes for all cables	
k.	Maximum outside diameter, (mm^2)	Manufacturer's data	
l.	Overall shield required	Yes	
m.	Type of shielding	Annealed copper tape with min. thickness of 0.5mm applied helically over the binder tape	
n.	Maximum operating temperature, °C	90	

B.3.4 600V Analog/Measuring (CT/PT) Cables

a.	No. of Conductors/Cable and Size [8]	4c x 6.0mm^2 for 5A 4c x 4.0mm^2 for 1A	
b.	Conductor material	Annealed copper stranded wire	
c.	Conductor shape	Circular (for all conductors)	
d.	Conductor cross-section, (mm^2) [9]	Manufacturer's data	
e.	Maximum outside diameter, (mm)	Manufacturer's data	
f.	Type of insulation	PVC	
g.	Thickness of insulation, not less than, (mm^2)	Manufacturer's standard	
h.	Type of jacket	PVC jacketed for all cables	

[8] *Contractor to give full description of various number of conductor/cables, sizes and ampacities.*
[9] *Contractor to fill-up the required data.*

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirements	Contractor's Data
i. Thickness of jacket/outer sheath, not less than, (mm)	1.8 for all cables	
j. Provided with filler and binder tape	Yes, for all cables	
k. Maximum outside diameter, (mm^2)	Manufacturer's data	
l. Overall shield required	Yes	
m. Type of shielding	Annealed copper tape with min. thickness of 0.5mm applied helically over the binder tape	
n. Maximum operating temperature, °C	90	

B.3.5 Test and Experience Requirements

B.3.5.1 Test Requirements

a. Design test in accordance with applicable standards and reports required *(Yes, No)*	Yes	
b. Certified Design Test Reports of previous tests conducted for same cables are acceptable:*(Yes, No)*	Yes	
c. Test frequency requirements	60 Hz	
d. Factory Acceptance Tests (Routine) to be witnessed by NPC	No	

B.3.5.2 Equipment and Manufacturer's Experience

a. The manufacturer should have been in the business of manufacturing power and control cables of not less than: Years	10	

Name of Firm	Name & Signature of Representative	Designation

B.4.0 BUS CONDUCTORS AND HARDWARES

B.4.1 Technical Characteristics and Requirements

	Contractor's Data
a. Manufacturers	
1. Conductors	
2. Conductor Hardwares and Materials	
3. Tubular Conductor	
b. Type and Designation [10]	
1. Conductors	
2. Conductor Hardwares and Materials	
3. Tubular Conductor	
c. Country of Origin	
1. Conductors	
2. Conductor Hardwares and Materials	
3. Tubular Conductor	

B.4.2 Stranded Conductor Requirements

	NPC Requirement	Contractor's Data
a. Type designation		
1. Bus section	N/A	
2. Bay section	Hard Aluminum alloy (HAL) or equivalent	
b. Code word		
1. Bus section	N/A	
2. Bay section	Manufacturer's standard	
c. Ampacity		
1. Bus section	N/A	
2. Bay section	600	

[10] *Contractor to give description of each item used.*

Name of Firm	Name & Signature of Representative	Designation

B.4.3 Tubular Bus Conductor (If Applicable)

	NPC Requirement	Contractor's Data
a. Type designation	Manufacturer's standard	
b. Code word	Manufacturer's standard	
c. Alloy type	Aluminum Alloy type	
d. Pipe schedule	Manufacturer's standard	
e. Ampacity	1200	
f. Pipe diameter	Corresponding to 1200 A ampacity	

B.4.4 Conductor Hardwares

a. Bus Support Clamps type	bolted	
1. Expansion bus support clamps	To be provided	
b. Connectors:		
1. Type	wedge pressure clamp for stranded conductor connection	
2. Angle and T-connectors type	wedge pressure clamp for stranded conductor connection	
c. Couplers, specify type	Stud to cable	
d. Dead-end assembly	Compression dead end	

Name of Firm	Name & Signature of Representative	Designation

B.4.5 Tests and Experience Requirements

B.4.5.1 Test Requirements

	NPC Requirement	Contractor's Data
a. Type test and/or design test reports required for the bus conductors and materials to be supplied *(Specify Yes or No)* [11]	Yes	

B.4.5.2 Equipment and Manufacturer's Experience

a. The manufacturer should have been in the business of manufacturing power conductors and hardwares for not less than: Years	10	

[11] *Supplier shall place in the filled-in data "submitted" or "will submit", "will perform" or "had been performed" as appropriate.*

Name of Firm	Name & Signature of Representative	Designation

B.5.0 GROUNDING SYSTEM

B.5.1 Technical Characteristics and Requirements

	Contractor's Data
a. Country of Origin	
1. Copper ground conductor	
2. Ground rods	
3. Grounding materials and accessories for Various type of connections	
b. Manufacturers	
1. Copper ground conductor	
2. Ground rods	
3. Grounding materials and accessories for Various type of connections	

B.5.2 Grounding Design Criteria

	NPC Requirement	Contractor's Data
a. Grounding connection *(Specify exothermic, compression, etc.)*	Exothermic for underground; Compression for exposed	
b. Bonding Conductor (riser)	≥100mm^2 tin-annealed copper stranded conductor with 3.3 kV PVC insulation	
c. Ground mat design resistance	0.5 ohms max.	
d. Ground rod		
1. Type	Copper clad	
2. Diameter, mm	Not less than 19	
3. Length/Section, mm	3000	
e. Soil resistivity (for calculation), ohmmeter	By Contractor [12]	
f. Recommended length per reel, if specified, m	1,500	

[12] *Design of grounding system is responsibility of Contractor including measurement of actual soil resistivity.*

Name of Firm	Name & Signature of Representative	Designation

B.5.3 Bonding Conductor (Riser)

		NPC Requirement	Contractor's Data
a.	Size, mm^2	$\geq$ 100 mm^2	
b.	Conductor, metal	$\geq$ 100mm^2 tin-annealed copper stranded conductor with 3.3 kV PVC insulation	
c.	Type of insulation	PVC	

B.5.4 Test and Test Report(s) Requirements

		NPC Requirement	Contractor's Data
a.	Type test and/or design test reports required for the grounding conductor and materials to be supplied (Specify Yes or No) [13]	Yes	
b.	Measurement of ground grid resistance after completion of grounding system. *(Specify Yes or No)*	Yes	
c.	Additional tests are required other than those specified in Section EW-5.5 of the Technical Specifications *(Yes, No)*	Yes	

B.5.5 Tools

In addition to those tools and devices recommended by the Contractor for the grounding system the following tools and devices shall be supplied for **Roxas Substation**.

		NPC Requirement	Contractor's Data
a.	Earthing Stick, separable type, with vinyl tube stick with 5m length insulated copper conductor of 38mm^2 bolt clamping type clamp, hung type head	2 pcs.	

[13] *Contractor shall place in the filled-in-data "submitted" or "will submit" as appropriate.*

Name of Firm | Name & Signature of Representative | Designation

B.6.0 13.8 KV PROTECTION, MONITORING AND CONTROL

B.6.1 Technical Characteristics and Requirements

	Contractor's Data
a. Manufacturer	
1. Feeder Protection	_____
2. Monitoring and Metering	_____
3. Instrument Transformers	_____
4. Terminal Blocks	_____
b. Country of Origin	
1. Feeder Protection	
2. Monitoring and Metering	_____
3. Instrument Transformers	_____
4. Terminal Blocks	_____

B.6.1 Feeder Protection Technical Features and Characteristics (13.8 kV feeders)

B.6.1.1 Relay Composition and Characteristics

	NPC Requirement	Contractor's Data
a. Construction	Microprocessor-based design (numerical/digital)	_____
b. Mounting	19" Rack Mounted	_____
c. Composition of the protection sets (Yes, No)		
1. Phase and ground time and instantaneous overcurrent relay	Yes	_____
3. Reclosing relay	Yes	_____
d. Provided with the following features and characteristics (Yes, No)	_____	_____
1. Trip circuit monitoring	Yes	_____
2. Status information (open, close) of circuit breaker and associated disconnect switches.	Yes	_____
3. Remote and local breaker control (trip and close)	Yes	_____
4. Breaker failure function provided (Yes, No)	Yes	_____
5. Provided with measurement functions with local display of:		

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
a) measured phase current	Yes	
b) Active and reactive power	Yes	
Provision for remotely acquisition of the above data.	Yes	
7. Extensive self-test and diagnostic	Yes	
8. Serial communication interface via RS232 or EIA-232 port	Yes	
e. Configuration Editor Software to be provided for the relay as part of the supply	Yes	

B.6.1.2 Over Current Operating Parameters and Technical Features

a. Mounting	19" rack mounted	
b. Will form part of micro-processor-based substation control and protection system (Yes, No)	No	
c. Application		
1. Phase instantaneous and phase time overcurrent plus ground overcurrent (instantaneous & time overcurrent)	Yes	
2. Overcurrent functions to be directional or non-directional	Non-directional	
d. Technical Features and Operating Parameters		
1. Type (Protective Function)	Instantaneous and time delayed elements for each of the three phases and ground	
2. Rated current	1A	
3. Rated frequency	60 Hz	
4. Choice of inverse time curves and time ranges for both phase and ground protection by separate setting switches provided on the relay front board [14]	Yes	

[14] *Contractor to indicate the proposed measuring ranges, i.e., instantaneous and time delayed.*

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirement	Contractor's Data
5.	Separate LED indicators provided on Individual measuring elements to indicate time delayed and instantaneous (for pick-up and tripping functions)	Yes	
6.	Separate output contracts provided for instantaneous phase faults, time delayed phase faults, instantaneous earth fault and time delayed earth fault operations	Yes	
7.	Provision for blocking the operation of the relay by external signals in both phase and ground units.	Yes	
8.	Instantaneous function with adjustable time delay	To be provided, preferred 0-2 sec. In steps of 0.01 sec.	
9.	Time delayed setting range		
	a) Phase relays operation	0.5 to 100 sec	
	b) Ground relays	0.5 to 100 sec	
10.	Resetting ratio (Drop-off/Pick-up Ratio)	95%	
11.	Current setting range		
	a) Phase relays		
	1) Instantaneous	0.1 to 20 In in steps of 0.1	
	2) Time delayed	0.02 to 20 In in steps of 0.01 In	
	b) Ground relay		
	1) Instantaneous	0.02 o 20 In in steps of 0.1	
	2) Time delayed	0.02 to 20 In in steps of 0.01 In	
12.	Overload capacity of current circuits		
	a) Continuous	3 times rated current for phase & neutral current	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
b) 1 sec.	100 times the rated current for phase & neutral current	
13. Provided with Breaker Fail function	Yes	
14. MTBF, year	By Contractor	

B.6.2 Monitoring and Metering Technical Features and Ratings

a. Technical Features

1. Device Application	Power Monitoring and Energy Metering	
2. Type of measurement	Current cumulative (kVAR), Energy delivered/ received (kWh), Reactive energy delivered (kVARh), Instantaneous power (kW), Maximum demand (kW), Voltage, Current Frequency, and Power factor	
3. Display Interface	LED or LCD	
4. Serial communication interface	SCADA Ready	
5. Installation	By Contractor	
5. Dimensions	By Contractor	

b. Operating Parameters

1. Rated Voltage, V	57 - 240	
2. Phase	3	
3. Current, A	5	
4. Accuracy Class	±0.2 or better	
5. Frequency, Hz	60	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data

B.6.3 Voltage Transformers Technical Features and Ratings

a. Nominal voltage of VT, kV	13.8	
b. Highest continuous operating voltage of VTs, kV	15	
c. Frequency, Hz	60	
d. Rated primary Voltage	8400	
e. Rated secondary voltage	120	
f. IEEE Accuracy Class	0.3	
g. Insulation Class, BIL	110 kV	
h. Insulating Medium	cast resin	

B.6.4 Current Transformers Technical Features and Ratings

a. Secondary rated current for all windings, A	5	
b. Highest system voltage, kV	15	
d. Burden/Accuracy class [15]	0.3 BO.9	
e. CT Ratio, Multi-Ratio	By Contractor	
f. Insulating Medium	cast resin	

B.6.6 Test and Experience Requirements

B.6.6.1 Normal Tests

a. Design Test and Certified Test Reports of Protection, Monitoring and Metering components required *(Yes, No)* [16]	Yes	
b. Test reports of licenser instead of his own (Contractor's manufacturer) is : *(acceptable, not acceptable)*	not acceptable	
c. Additional tests are required *(Yes, No)*	Yes	
d. Test frequency requirements	60 Hz	

[15] *Accuracy class/Burden of Instrument Transformers are indicative/for bidding purposes only, required design rating shall be determined by the Contractor subject to NPC's approval.*

[16] *Contractor shall place in the filled-in data "submitted" or "will submit", "will perform" or "had been performed" as appropriate.*

Name of Firm	Name & Signature of Representative	Designation

B.6.6.2 Equipment and Manufacturer's Experience

	NPC Requirement	Contractor's Data
a. The manufacturer should have been in the business of manufacturing the equipment of not more less than: Years	10	
b. The equipment offered should have been in the actual service for not less than: Years	3	

B.6.7 Spare Parts

The following parts aside from those Contractor's recommended spare parts shall be furnished for the main control switchboard for **Roxas Substation.**

a. Unit(s) of each relay of each type used	2	
b. Unit(s) of each type of monitoring and metering device used	1	

B.6.6 Tools

In addition to those tools and devices recommended by the Contractor for the main control switchboard, the following tools and devices shall be supplied:

a. Terminal press tool and screw drivers kit with tool box containing the following:		
1. Press tool for 2 mm^2 - 38 mm^2 conductors, manual operation type	1	
2. Stripper, remover of vinyl insulation of 1.5 mm^2 - 8 mm^2 conductors, spring return type	1	
3. Cable sheath remover, for cutting cable sheath in the sectional axial direction for cable *(PVC & XLPE)*, 3.5 mm^2 x 2C - 22 mm^2 x 2C	1	
4. Set of screw drivers of various sizes *(12 different)* suited for control board wiring terminals	1	
b. Home kit with tool box with the following content:		
1. Drill Chuck	1	
2. Set of pliers of various sizes	1	

Name of Firm | Name & Signature of Representative | Designation

	NPC Requirement	Contractor's Data
3. Wool bonnet	2	
4. Electric drill capable of accepting 3.5 mm - 10 mm size of drill diameter, 1-ϕ, 220 Vac	1	
5. Spare drill		
a. 3.5 mm diameter	5 pcs.	
b. 5.0 mm diameter	5 pcs.	
c. 7.0 mm diameter	5 pcs.	
d. 10.0 mm diameter	5 pcs.	
6. Spare carbon brushes	10 pcs.	

Name of Firm	Name & Signature of Representative	Designation

B.7.0 STORAGE BATTERIES

B.7.1 Technical Requirements

	Contractor's Data
a. Manufacturer	
1. 125 Vdc	
b. Country of Origin	
1. 125 Vdc	

B.7.2 Technical Features and Requirements

	NPC Requirements	Contractor's Data
a. Nominal Voltage Rating of Battery System	125 Vdc	
b. Number of cells per battery		
1. 125 Vdc	60	
c. Cell Type	Lead Antimony	
d. Plate type	pasted plate	
e. Technology *(Vented, Sealed)*	Vented	
f. End of duty cycle voltage or minimum voltage during duty cycle (volts per cell -VPC)		
1. 125 Vdc	105	
g. Max. allowable voltage or equalizing voltage		
1. 125 Vdc	140	
h. Equalizing charge voltage (VPC)	2.33	
i. Max. float voltage, VPC	2.23 for Antimony alloy 2.25 for Calcium alloy	
j. Normal float voltage, VPC	2.17 for Calcium alloy 2.15 for Antimony alloy	
k. Open Circuit Voltage (Fully charged), VPC	2.05 for all types of lead-acid batteries	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirements	Contractor's Data
l. Ampere Hour Capacity at 10-hour discharge rate to 1.75 volts per cell [17]		
1. 125 Vdc	200AH	
m. Electrolyte specific gravity at 25°C	1.210	
n. Battery Room Parameters:		
1. Coldest temperature in battery room	20°C	
2. Hottest temperature in battery room	40°C	
3. Battery room design temperature	25°C	
4. Battery room relative humidity	95% non-condensing	
o. Insulated Cable Connections and Insulated Terminal Lugs	To be provided	
1. Connecting power cable: a) Size	By Contractor	
b) Number of cables per positive or negative pole	By Contractor	
2. Terminal lugs for power cable, to be provided *(Yes, No)*	To be provided	
3. Ground cable size for battery rack:	100 mm^2 insulated copper stranded conductor	
p. Battery to be used in a grounded dc system *(Yes, No)*	No	
q. No. of battery bank		
1. 125 Vdc	1	
r. External Vent Plug recombinator (Gas recombinator)		
1. 125 Vdc	Required for each cell	

[17] *Contractor to submit design calculations.*

Name of Firm	Name & Signature of Representative	Designation

B.7.3 Tests and Experience Requirements

B.7.3.1 Normal Tests

	NPC Requirements	Contractor's Data
a. Capacity tests shall be performed on the batteries in accordance with this specification *(Yes, No)*	Yes	
b. Test reports of Licenser instead of his own (manufacturer) is: *(not acceptable, acceptable)*	not acceptable	

B.7.3.2 Equipment and Manufacturer's Experience

a. The manufacturer should have been in the business of manufacturing the equipment for not less than: years	10	

B.7.4 Spares and Spare Parts

The following spares and spare parts shall be furnished for the batteries for **Roxas Substation.**

a. Complete battery cell	2 of each type	
b. Extra cable terminals	3 each for 125 Vdc	
c. Extra inter cell connectors and cable	3 each for 125 Vdc	
d. Pre-mixed spare electrolyte	N/A	
e. Extra distilled water, in 20 liters container	N/A	
f. A quantity of protective no-oxide grease for connections, in cans	1-can in liter size	

B.7.5 Tools

In addition to those tools and devices mentioned in Section EW-7.3.4 of the Technical Specifications, the following shall be provided for **Roxas Substation.**

a. Connector bolt wrenches	1	
b. Plastic funnels	N/A	

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirements	Contractor's Data
c.	Cell lifting device	2	
d.	Rod thermometer	N/A	
e.	Digital Voltmeter Tester	1	
f.	Maintenance Tool Box	1 set	
g.	Battery Conductance Tester	1 set	

B.7.6 Other Technical Data to be Filled-in by Contractor

The Contractor furnished data and information are included in this Specification to indicate the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor furnished equipment. The accuracy of such information and the compatibility of such information with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

	Contractor's Data
a. Battery Type	
1. 125 Vdc	
a) Lead Calcium (LC), Lead Antimony (LA), other	
b) Positive plate construction (plante, pasted plate, etc.)	
c) Number of positive plates per cell	
b. Recommended battery charger data:	
1. Floating voltage range	
a) 125 Vdc	
2. Equalizing voltage range	
a) 125 Vdc	
3. Current rating	
a) 125 Vdc	
c. Heat released in BTU/hour during:	
1. discharge duty cycle	
a) 125 Vdc	
2. float charge	
a) 125 Vdc	
3. equalizing charge	
a) 125 Vdc	

Name of Firm	Name & Signature of Representative	Designation

	Contractor's Data
d. Max. amount of hydrogen gas that will be evolved per hour during battery equalizing charge at max. battery temperature (cubic feet H2/ cell x hour)	
1. 125 Vdc	
e. H_2 evolution at float ft^3 H_2/cell x hour	
f. Service life multiplier	
g. Battery rack	
1. Rack outline or Catalog no.	
2. Quantity of racks for the battery	
3. Description (seismic or other)	
h. Intercell connectors:	
1. Type	
a) 125 Vdc	
2. Material	
a) 125 Vdc	
i. Terminal lugs for NPC power cable:	
1. Manufacturer	
2. Type no.	
j. Terminal lugs for NPC's ground cable:	
1. Manufacturer	
2. Type no.	
k. Performance Data	
1. Float voltage (volts per cell-VPC) without equalizing	
a) 125 Vdc	
2. Voltage (volts per cell-VPC) with equalizing	
a) 125 Vdc	
3. Float voltage (volts per cell-VPC) with equalizing	
a) 125 Vdc	
4. Recommended frequency of equalizing charge	
a) 125 Vdc	
5. Recommended duration of equalizing charge	
a) 125 Vdc	

Name of Firm	Name & Signature of Representative	Designation

	Contractor's Data
6. Short-circuit current at short circuited (bolted) battery terminals at floating voltage:	
a) At 77°F	
1) 125 Vdc	_____
b) At hottest battery room temperature	
1) 125 Vdc	_____
7. Battery discharge characteristics (Contractor's reference curve number) [18]	_____
8. Guaranteed capacity to specified final voltage	
a) One minute, Ampere	_____
b) 30 minutes, Ampere	_____
c) 60 minutes, Ampere	_____
d) 120 mins., Amp-hour	_____
e) 4 hours, Amp-hour	_____
f) 5 hours, Amp-hour	_____
9. Specific gravity of electrolyte at 77°C	_____

[18] *Contractor to provide brief description.*

Name of Firm	Name & Signature of Representative	Designation

B.8.0 BATTERY CHARGER

B.8.1 Technical Requirements

		Contractor's Data
a.	Manufacturer(s)	
b.	Type and Designation	
c.	Country of Origin	

B.8.2 Technical Features and Requirements

		NPC Requirement	Contractor's Data
a.	Construction	Industrial Type	
b.	Primary input power supply		
	1. Voltage	230 V	
	2. Frequency	60 Hz	
	3. Phase/Wire	3-phase/4 wire	
	4. System Grounding *(solid, high resistance, ungrounded)*	Solid	
	5. Available short-circuit current *(amperes rms sym.)* at rated voltage [19]	Manufacturer's Data	
	6. Steady state voltage variation	±10%	
	7. Frequency variation	±5%	
c.	Battery Charger Output Data		
	1. The Contractor shall be responsible for the detailed design of the battery charging system and for the determination of the battery charger ratings	Yes	
	2. Nominal Output Voltage		
	a) 125 Vdc	125	
	3. Output Voltage Adjustment Range (minimum)		
	a) Float Voltage		
	1) 125 Vdc	120-130	
	b) Equalizing Voltage		
	1) 125 Vdc	130-140	

[19] *To be coordinated with AC and DC Station Auxiliary Switchboard.*

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirement	Contractor's Data
4.	Float Voltage Regulation for 0-100%, ±10% line voltage variation and ±5% frequency variation	1% maximum	
5.	Rated continuous current output at max. ambient temperature and site elevation		
	a) at max. dc voltage		
	1) 125 Vdc	By Contractor	
	b) at min. dc voltage		
	1) 125 Vdc	By Contractor	
	c) at nominal dc voltage		
	1) 125 Vdc	By Contractor	
6.	Battery Recharge Current	By Contractor	
7.	Charger current limit, % of continuous output	150 to 250	
8.	RMS Ripple, mV		
	a) Without battery connected	per ANSI/IEC Std.	
	b) With battery connected	100 mV (max.)	
9.	Time required to completely recharge full discharged battery plus supply station loads, hrs.	10	
10.	Min. efficiency by 50% load	80%	
11.	Min. efficiency by 50-100% load	85%	
d.	Battery Data		
1.	Nominal battery voltage	125 Vdc	
2.	Number of cells		
	a) 125 Vdc	60	
3.	Float Voltage (Volts/Cell), max.	2.23 for Antimony alloy and 2.25 for calcium alloy	
4.	Charging Voltage (Volts/Cell)	2.30	
5.	Boost Charging	2.65	
6.	Equalize voltage (volts/cell)	2.33 max.	
7.	Minimum Voltage (Volts/Cell)	1.75	
8.	Cell Type	By Contractor	
9.	Battery short-circuit current	By Contractor	
e.	Maximum sound level, dB (A)	50	

Name of Firm	Name & Signature of Representative	Designation

B.8.3 Other Technical Features

		NPC Requirement	Contractor's Data
a.	Equalizing Timer	To be provided	
b.	Equalizing Timer	Automatic with manual provision	
c.	Filtered output	To be provided	
d.	DC output operation	Ungrounded	
e.	With transient voltage surge suppression on the input side of the charger	To be provided	
f.	Boost charge, charge failure, loss of AV input and ground fault indication shall be provided at the charger panel (except for 48Vdc)	Yes	
g.	Monitoring of Equipment parameters for Current, Voltage, Frequency, Power (Input, Output, Battery, etc.) through digital monitor on the front panel of the equipment	Yes	
h.	Monitoring of equipment through Active Mimic Display on the front panel of equipment	Yes	
i.	Provision with automatic recharging/charging facilities	Yes	
j.	Provision of temperature DC voltage compensation and Battery discharge test	Yes	
k.	Cable entry		
	1. AC Power input	Bottom	
	2. DC output	Bottom	
l.	Cable sizes, mm^2		
	1. AC supply		
	a) 125 Vdc	By Contractor	
	2. DC output		
	a) 125 Vdc	By Contractor	
m.	Size of grounding cable for connection to ground bus of charger	≥100 mm^2 copper stranded conductor	

Name of Firm	Name & Signature of Representative	Designation

B.8.4 Tests and Experience Requirements

B.8.4.1 Normal Tests

	NPC Requirement	Contractor's Data
a. Is battery charger design new or of previous design with substantial changes in design and/or rating	By Contractor	
1. If new, design test and routine and reports required	Yes	
2. If previous design of same rating and voltage level, certified design reports of prototype or duplicate production type are acceptable	Yes	
b. Routine Tests to be performed on all chargers whether new or previous design	Yes	
c. Certified Routine Tests Reports to be submitted (Yes, No)	Yes	
d. Test reports of Licenser instead of his own (manufacturer) is:	not acceptable	
e. Test frequency requirement	60 Hz	

B.8.4.2 Equipment and Manufacturer's Experience

a. The manufacturer should have been in the business of manufacturing the equipment for not less than: years	10	
b. The type of equipment being offered should have been in the actual service for not less than: years	3	

B.8.5 Auxiliary Power Supply

The following auxiliary power shall be provided for the Battery Charger.

a. Power Supply, input	230 V, 3-Φ, 60 Hz	
b. Annunciator system, Vdc	125 Vdc	
c. Heaters, (if required)	230 V, 1-Φ, 60 Hz	

Name of Firm	Name & Signature of Representative	Designation

B.8.6 Spares and Spare Parts

The following spares and spare parts aside from those Contractor's recommended spare parts shall be furnished for the battery charger for **Roxas Substation:**

		NPC Requirement	Contractor's Data
a.	Plug-in control module of each type used, sets	1 each for the 125Vdc	
b.	Set of thyristors and silicon rectifiers of each type used	1 each for the 125Vdc	
c.	Fans used, (if required), pcs.	N/A	

B.8.7 Other Technical Data to be Filled-in by Contractor

The Contractor furnished data and information are included in this Specification to indicate the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor furnished equipment. The accuracy of such information and the compatibility of such information with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

		Contractor's Data
a.	Battery Charger Input Data	
	1. Input ac voltage, max/min, V	
	2. Input ac current at rated output	
	a) rated voltage, A	
	b) at min. ac voltage, A	

Name of Firm	Name & Signature of Representative	Designation

B.9.0 SUBSTATION PROTECTION SYSTEM

B.9.1 Transformer Protection Technical Features and Characteristics

B.9.1.1 Transformer Technical Data

		NPC Requirement	Contractor's Data
a.	Capacity	10 MVA	
b.	Voltage rating, kV		
	1. High voltage	69	
	2. Low voltage	13.8	
c.	Type (specify auto-transformer, 3-winding, 2- winding)	2 winding	
d.	No. of phase	3-phase	
e.	Winding connection		
	1. High voltage winding	Delta	
	2. Low voltage winding	Wye w/ neutral grounded	
f.	Method of grounding (specify solidly grounded, low resistance, reactance, etc.)	solidly grounded	

B.9.1.2 Relay Composition and Characteristics

a.	Construction (specify micro-processor based, static, etc.)	Digital/ Numerical [20]	
b.	Mounting	19" rack mounted	
c.	If individual relays are to be supplied, required no. of protection sets for single transformer (specify one, two, etc.) [21] [22]	One	
d.	Composition of protection sets, if more than one protection set is required (Yes, No)		
	1. Differential relay	Yes	
	2. Over-excitation / Over fluxing	Yes	
	3. Lock-out relay	Yes	
	4. Overvoltage Relay	Yes	
	5. Restricted earth fault	Yes	
	6. Overcurrent relay	Yes	
	7. Neutral overcurrent protection	Yes	

[20] *If a numerical protection system is proposed, it shall have an integrated overcurrent (if required), overload and over fluxing (if required) relays as back-up for the differential protection function. These details shall be contained in the protection cubicle.*

[21] *The technical data stated are taken from the requirements of both ANSI/IEEE C.37.91 and IEC 255. Contractor shall fill-up the applicable data requirements stated above for the relay to be supplied.*

[22] *If a numerical protection system is proposed, it shall have an integrated overcurrent (if required), overload and over fluxing (if required) relays as back-up for the differential protection function. These details shall be contained in the protection cubicle.*

Name of Firm	Name & Signature of Representative	Designation

B.9.1.3 Transformer Differential Relay Operating Parameters and Technical Parameters [23]

	NPC Requirement	Contractor's Data
a. Type		
1. Percentage differential with harmonic restraint (Yes, No)	Yes	
b. If percentage differential with harmonic restraint:		
1. No. of restraint inputs	4	
2. Harmonic restrained operate time, ms	By Contractor	
3. Unrestrained operate time, ms	By Contractor	
4. Harmonic restraint	restraint for 2nd & higher	
5. Sensitivity (Restrained operate value)	Settable to 20-50% of rated current	
6. Unrestrained high speed operate value	Settable to 8-20 times rated current	
7. Restraint percentage	By Contractor	
8. CT ratio matching	By Contractor	
c. Common Requirements		
1. Rated current	1A	
2. Rated frequency	60 Hz	
3. Overload capacity		
a) continuous	20 A	
b) 2 sec	200 A	
4. MTBF, year	By Contractor	

B.9.1.4 Overexcitation/Over fluxing Relay Operating Parameters and Technical Features

a. Overexcitation sensing unit	To be provided	
b. Timing unit to provide selectable inverse time and definite minimum time characteristics	To be provided	
c. Rated voltage, V	90-300V	
d. Rated frequency	60 Hz	
e. Flux setting range	1.0 to 1.25 rated flux	
f. Operating range, Hz	1.5-3	
g. Definite time setting range for alarm, s	0.5 - 5	

[23] *If a numerical protection system is proposed, it shall have an integrated overcurrent, overvoltage (if required), overload and over fluxing (if required) relays as back-up for the differential protection function. These shall be contained in the protection cubicle.*

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
h. Inverse time operating characteristics for tripping range, sec	By Contractor	
i. MTBF, year	By Contractor	

B.9.1.5 Overcurrent Relays Operating Parameters and Technical Features

a. Application		
1. Phase instantaneous and phase time overcurrent plus ground overcurrent (instantaneous & time overcurrent) on the high voltage side of the transformer to be provided	Yes	
2. Same for item 1 but applies on the low voltage side of the transformer	Yes	
3. Phase time and ground overcurrent function applied on the tertiary side of the transformer to be provided	Yes	
4. Overcurrent functions to be directional or non-directional	non-directional	
b. Technical Features and Operating Parameters of Item B.9.1.5.a.1 & 2:		
1. Type (Protective Function)	Instantaneous and time delayed elements for each of the three phases and ground	
2. Rated current	1A	
3. Rated frequency	60 Hz	
4. Choice of inverse time curves and time ranges for both phase and ground protection by separate setting switches provided on the relay front board [24]	Yes	

[24] *Contractor to indicate the proposed measuring ranges, i.e., instantaneous and time delayed.*

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirement	Contractor's Data
5.	Separate LED indicators provided on individual measuring elements to indicate time delayed and instantaneous operations (for pick-up and tripping functions)	Yes	
6.	Separate output contacts provided for instantaneous phase faults, time delayed phase faults, instantaneous earth fault and time delayed earth fault operations	Yes	
7.	Provision for blocking the operation of the relay by external signals in both phase and ground units	Yes	
8.	Instantaneous function provided with adjustable time delay	Yes, preferred 0-2 sec. In steps of 0.01 sec.	
9.	Resetting ratio (Drop-off/ Pick-up Ratio)	>95%	
10.	Time delayed setting range		
	a) Phase relays operation	0.1 to 100 sec	
	b) Ground relays	0.1 to 100 sec	
11.	Current setting range:		
	a) Phase relays		
	1) Instantaneous	10 - 100 A	
	2) Time delayed	4 – 20 A	
	b) Ground relay,		
	1) Instantaneous	10 – 40 A	
	2) Time delayed	0.1 – 5 A	
12.	Overload capacity of current circuits		
	a) Continuous	3 times rated current for phase & neutral current	
	b) 1 sec	100 times the rated current for phase & neutral current	
13.	Provided with breaker fail function	Yes	
14.	MTBF, year	By Contractor	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
c. Technical Features and Operating Parameters of Item B.9.1.5.a.3:		
1. Type (Protective Function)	Instantaneous (optional) and time delayed elements for each of the three phases and ground	
2. Rated current	1A	
3. Rated frequency	60 Hz	
4. Choice of inverse time curves and time ranges for both phase and ground protection by separate setting switches provided on the relay front board	Yes	
5. Separate LED indicators provided on individual measuring elements to indicate time delayed and instantaneous operations	Yes, preferred	
6. Separate output contacts provided for overcurrent and ground relay measuring elements	Yes, preferred	
7. Provision for the instantaneous function of the relay to be blocked or delayed	Yes [25]	
8. Start operation parameters		
a. Current setting range		
1. Phase relays Instantaneous (optional)	0.1 to 20 In in steps of 0.1 In	
2. Time delayed	0.2 to 20 In in steps of 0.1 In	
b. Ground relay		
1. Instantaneous	0.1 to 20 In in steps of 0.1 In	
2. Time delayed	0.2 to 20 In in steps of 0.1 In	
c. Drop-off/ Pick-up Ratio	95%	

[25] *Contractor to give full description on the time delayed function.*

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
9. Time delayed operation parameters		
a. Phase relays	0.1 to 100 sec	
Time delayed operation parameters		
a. Phase relays	0.1 to 100 sec	
b. Ground relays	0.1 to 100 sec	
10. Instantaneous operation provided with adjustable time delayed (Yes, No)	Yes, preferred	
11. Overload capacity of current circuits		
a. Continuous	2 times rated current phase & neutral current	
b. 1 sec	75 times rated current, phase & neutral current	
12. MTBF, year	By Contractor	

B.9.1.6 Neutral Current Protection Operating Parameters and Technical Features

a. Setting range, step 1, Instantaneous (optional)		
1. Current, A	0.1 to 20 In in steps of 0.1 In.	
2. Operating time	< 40ms	
b. Setting range, step 2, Time delay		
1. Current, A	0.1 to 20 In in steps of 0.01 In	
2. Time delay, sec	0.02 to 60 s in steps of 0.01 s	
c. Methods of stabilizing for in-rush current [26]	By Contractor	
d. MTBF, year	By Contractor	

B.9.1.7 Restricted Earth Fault Operating Parameters and Technical Features

a. Rated frequency	60 Hz	
b. Type, low or high impedance	By Contractor	
c. Setting range, A or V	By Contractor	
d. With CT ratio compensation	Yes	
e. Operating time, ms	10-20 ms	
f. Method of stabilizing for dc component	By Contractor	
g. MTBF, year	By Contractor	

[26] *Contractor to give brief description.*

Name of Firm	Name & Signature of Representative	Designation

B.9.1.8 Lock-out Relay Operating Parameters and Technical Features

		NPC Requirement	Contractor's Data
a.	Type (specify manual reset, electrical reset, etc.)	Manual reset	
b.	Operating time, ms	≥ 15 ms	
c.	No. of contacts required	To be coordinated with the no. of associated relays	
d.	Trip coil voltage operating range	70-145 Vdc	
e.	Contact ratings		
	1. Continuous	20 A	
	2. 1 min	40 A	

B.9.2 Breaker Fail Protection Operating Parameters and Technical Features (Not Used)

B.9.3 Feeder Protection Technical Features and Characteristics (69 kV feeders)

B.9.3.1 Relay Composition and Characteristics (If required)

		NPC Requirement	Contractor's Data
a.	Construction	Microprocessor based or Numerical protection system	
b.	Mounting	19" rack mounted	
c.	Composition of the protection sets (Yes, No)		
	1. Phase and ground time and instantaneous overcurrent relay	Yes	
	2. Reclosing relay	Yes	
d.	Provided with the following features and characteristics (Yes, No)		
	1. Trip circuit monitoring	Yes	
	2. Status information (open, close) of circuit breaker and associated disconnect switches.	Yes	
	3. remote and local breaker control (trip and close)	Yes	
	4. Breaker failure function provided (Yes, No)	Yes	
	5. Provided with measurement functions with local display of:		
	a) measured phase current	Yes	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
b) Active and reactive power	Yes	
Provision for remotely acquisition of the above data.	Yes	
7. Extensive self-test and diagnostic	Yes	
8. Serial communication interface via RS232 port	Yes	
e. Configuration Editor Software to be provided for the relay as part of the supply	Yes	

B.9.3.2 Over Current Relays Operating Parameters and Technical Features (If required)

a. Mounting	19" rack mounted	
b. Will form part of micro-processor-based substation control and protection system (Yes, No)	No	
c. Application		
1. Phase instantaneous and phase time overcurrent plus ground overcurrent (instantaneous & time overcurrent)	Yes	
2. Overcurrent functions to be directional or non-directional	Non-directional	
d. Technical Features and Operating Parameters of Item B.9.1.5.a.1 & 2:		
1. Type (Protective Function)	Instantaneous and time delayed elements for each of the three phases and ground	
2. Rated current	1A	
3. Rated frequency	60 Hz	
4. Choice of inverse time curves and time ranges for both phase and ground protection by separate setting switches provided on the relay front board [27]	Yes	

[27] *Contractor to indicate the proposed measuring ranges, i.e., instantaneous and time delayed.*

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirement	Contractor's Data
5.	Separate LED indicators provided on Individual measuring elements to indicate time delayed and instantaneous (for pick-up and tripping functions)	Yes	
6.	Separate output contracts provided for instantaneous phase faults, time delayed phase faults, instantaneous earth fault and time delayed earth fault operations	Yes	
7.	Provision for blocking the operation of the relay by external signals in both phase and ground units.	Yes	
8.	Instantaneous function with adjustable time delay	To be provided, preferred 0-2 sec. In steps of 0.01 sec.	
9.	Resetting ratio (Drop-off/Pick-up Ratio)	95%	
10.	Time delayed setting range		
	a) Phase relays operation	0.5 to 100 sec	
	b) Ground relays	0.5 to 100 sec	
11.	Current setting range		
	a) Phase relays		
	1) Instantaneous	0.1 to 20 In in steps of 0.1	
	2) Time delayed	0.02 to 20 In in steps of 0.01 In	
	b) Ground relay		
	1) Instantaneous	0.03 o 20 In in steps of 0.1	
	2) Time delayed	0.02 to 20 In in steps of 0.01 In	
12.	Overload capacity of current circuits		
	a) Continuous	3 times rated current for phase & neutral current	
	b) 1 sec.	100 times the rated current for phase & neutral current	

Name of Firm	Name & Signature of Representative	Designation

	NPC Requirement	Contractor's Data
13. Provided with Breaker Fail function	Yes	
14. MTBF, year	By Contractor	

B.9.3.3 Monitoring and Metering Technical Features and Ratings

a. Technical Features

1. Device Application	Power Monitoring and Energy Metering	
2. Type of measurement	Current cumulative (kVAR), Energy delivered/ received (kWh), Reactive energy delivered (kVARh), Instantaneous power (kW), Maximum demand (kW), Voltage, Current Frequency, and Power factor	
3. Display Interface	LED or LCD	
4. Serial communication interface	SCADA Ready	
5. Installation	By Contractor	
5. Dimensions	By Contractor	

b. Operating Parameters

1. Rated Voltage, V	57 - 240	
2. Phase	3	
3. Current, A	5	
4. Accuracy Class	±0.2 or better	
5. Frequency, Hz	60	

Name of Firm	Name & Signature of Representative	Designation

B.9.4 Test and Experience Requirements

B.9.4.1 Test Requirements

		NPC Requirement	Contractor's Data
a.	Design Test and Reports Required for each of the Relay component [28]	Yes	
b.	Certified test design reports of previous or duplicate production type are acceptable [51]	Yes	
c.	Additional tests are required, if yes, see B.9.3.2	Yes	
d.	Test reports of Contractor instead of manufacturer:(acceptable, not acceptable)	not acceptable	
e.	Test frequency requirements	60 Hz	
f.	Factory acceptance tests to be witnessed by NPC	No	
g.	Required no. of personnel to witness Factory Acceptance Tests	N/a	

B.9.4.2 Additional Tests

If additional tests are required (see B.9.4.1.c), they shall be as follows:

Manufacturer's tests standards not within the specified tests of either ANSI or IEC standards.

B.9.4.3 Equipment and Manufacturer's Experience

		NPC Requirement	Contractor's Data
a.	The manufacturer should have been in the business of manufacturing protective relays of not less than: Years	10	
b.	The type of equipment offered should have been operating satisfactorily in the actual service for not less than: Years	3	
c.	The minimum quantity of equipment of similar characteristics in actual service as stipulated in item b.	4	

Note: Experience less than what is required will be ground for rejection of equipment being offered.

[28] *Contractor shall place in the fill-in data "submitted" or "will submit", "will perform" or "had been performed" as appropriate.*

Name of Firm	Name & Signature of Representative	Designation

B.9.5 Auxiliary Power Supply

The items listed below should be designed to receive auxiliary voltage source indicated in the NPC requirement.

		NPC Requirement	Contractor's Data
a.	Power Supply	125 Vdc +10%, -15%	
b.	Annunciator system, Vdc	125 Vdc +10%, -15%	
c.	Internal lights and convenience outlets, Vac	230 V, 1-ϕ, 60 Hz for lights 15 A, 230 V, 1-ϕ, 60 Hz for CO	
d.	Heaters, Vac (if required)	230 V, 1-ϕ, 60 Hz	

B.9.6 Spares and Spare Parts

The following parts aside from those Contractor's recommended spare parts shall be furnished for the Substation Protective Relay Equipment for **Roxas Substation.**

1.	Transformer Differential Relay complete with the required back-up and auxiliary relays w/o panel	1 unit	
2.	Feeder Protection Relay		
	a. Feeder Overcurrent Relay w/o panel	1 unit	

All spare parts shall be hermetically sealed and shall be specifically packed for storage for an extended period of time and shall come complete with storage instructions.

All spare parts shall be interchangeable with and identical in all respect to the original parts.

Name of Firm	Name & Signature of Representative	Designation

B.9.7 Tools

A portable PC is required for maintenance, testing, re-configuration and data access of the substation protection equipment, it shall be connected via a service interface RS232-C port at 9600 baud. Provision therefore for this interface port shall be provided for the Protective Relay terminal equipment. The servicing PC to be supplied must have the following minimum technical requirements:

		NPC Requirement	Contractor's Data
a.	Type	PC Compatible notebook/laptop computer	
b.	Hardware		
1.	Processor	Intel Core i9 or Latest Model Available	
2.	Clock Frequency, GHz	Fastest speed available	
3.	Memory, GB	256 (min.)	
4.	Hard disk capacity	2TB SSD & 4TB HDD	
5.	Video Card	Largest available	
6.	CD-ROM drive/ DVD ROM drive	latest speed (built-in)	
7.	Display	14" 720p(min.) Active TFT Color Matrix Display LCD color	
8.	Audio system	64-bit stereo audio system w/ crystal sound dual speaker	
9.	Network Interface	10/100/1000 MBps (built-in)	
c.	Software		
1.	Operating system	Licensed Windows 10 Professional 64-bit, pre-installed with back-up DISC and reference manuals; Licensed Microsoft Office 2016 Professional Plus	
2.	Communication stack	OSI-TCP / IP	
3.	Configuration tools *(specify provided, not provided)*	Provided with Back-up copy	

Name of Firm	Name & Signature of Representative	Designation

		NPC Requirement	Contractor's Data
4.	Maintenance tools *(specify provided, not provided)*	Provided with back up copy	
d.	Peripheral connectivity		
1.	Communication interface (I/O)	1x9-pin RS232 Serial & 1x25-pin ECP/EPP parallel ports, 3xUSB3.0, VGA port, 4-in-1 SD Card reader, Phone Line in, 3.5mm Microphone in ports, DC jack for power adapter,	
e.	Keyboard	84/85 key w/ embedded numeric key pad	
f.	Mouse	Optical Sensor type with scroll wheel	
g.	Power Adaptor	100 – 240V full range 50 – 60 Hz	
h.	Battery	Li-Ion battery pack 6-8 hrs. rundown battery life w/ APM	
i.	No. of units to be provided	Two (2)	

Name of Firm | Name & Signature of Representative | Designation

B.9.8 Other Technical Requirements

a. The protection panel shall accommodate the desired relay components shown in the bid drawing's single line diagrams.

	NPC Requirement	Contractor's Data
b. Is the Substation Protective Relay equipment to be supplied already existing in the Grid where it will be installed? (Yes, No)	By Contractor	
1. If Yes:		
a) Was training at the manufacturer's place conducted for the NPC engineers	Yes	
b) Was local training also conducted by the Contractor for the NPC engineers	Yes	
c) Training overseas required? (Yes, No)	No	
d) Local training required? (Yes, No) Refer to Section GW-2.12.2 of the Technical Specifications	Yes	
2. If No:		
a) Training overseas required? (Yes, No) Refer to Section GW-2.12.2 of the Technical Specifications	No	
b) Local training required? (Yes, No) Refer to Section GW-2.12.2 of the Technical Specifications	Yes	

B.9.9 Other Technical Data to be Filled-in by Contractor

The Contractor furnished data and information are included in this Specification to indicate the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor furnished equipment. The accuracy of such information and the compatibility of such information with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

Name of Firm	Name & Signature of Representative	Designation

	Contractor's Data
a. Physical Dimensions and Weights	
1. Dimension, (L x W x H), mm	
a) Transformer Protective Relay	
b) Breaker Failure Relay	
c) Bus Protective Relay	
d) Feeder Protective Relay	
2. Weights w/o crate, kg	
a) Transformer Protective Relay	
b) Breaker Failure Relay	
c) Bus Protective Relay	
d) Feeder Protective Relay	
3. Weights with crate, kg	
a) Transformer Protective Relay	
b) Breaker Failure Relay	
c) Bus Protective Relay	
d) Feeder Protective Relay	

Name of Firm	Name & Signature of Representative	Designation

EW-8.3.7 Accessories

Contractor shall provide accessories as required for proper operation and maintenance of the equipment.

EW-8.3.8 Other Technical Requirements for the Charger/Rectifier

Other technical features for the battery charger/rectifier, if required by the NPC are stated in the Technical Data Sheets.

EW-8.4 INSTALLATION

Installation will be by Contractor as specified in Section B.1.0 of the Technical Data Sheets.

When the installation is by Contractor, such as for turnkey contracts, complete details of proper handling, transport and storage, installation, testing, commissioning, performances guarantee, etc. shall be furnished for NPC's review and approval.

EW-8.5 TESTS

EW-8.5.1 Material Tests

All materials shall comply with test criteria, and NPC acceptance of the equipment shall not relieve Contractor of his responsibility for meeting all the requirements of this specification. The Contractor shall carry out at his own expense all tests necessary to ensure the satisfactory design and manufacture of battery charger/rectifier in accordance with ANSI/IEEE or IEC equivalent.

EW-8.5.2 Shop Test

The charger shall be completely wired and at the factory and given standard factory inspection, wiring check, operation and dielectric tests to insure completeness, adequacy, and proper functioning of equipment in accordance with the requirements of this specification, standards and codes. Even though Contractor performs the required tests and the equipment meets the acceptance criteria, Contractor shall not be relieved of the responsibility of providing equipment conforming to all the requirements of the specification.

The control wiring shall be factory tested as follows:

a. Each circuit shall be given a continuity test.

b. Each circuit shall be given an insulation resistance test with equipment connected, using a 100volt megger. The insulation resistance shall not be less than 25 megaohms. (This test is not applicable to circuits containing semiconductors).

Assembled battery charger shall be tested in accordance with applicable standards.

Surge withstand test will be conducted using the appropriate sections of ANSI C37.90 or IEC 60255-22 as a guide.

EW-8.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-8.6.1 General

Contractor furnished data and information shall be the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor's furnished equipment. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder. Any deviation from such data requires NPC's approval.

EW-8.6.2 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the filled-in Section B.8.0 of the Technical Data Sheets.

EW-8.6.3 Data and Information to be Submitted After Award of Contract

After award of the contract, the Contractor shall furnish drawings and data, in quality and quantity as specified herein and in purchase order, for NPC's review and acceptance as follows:

a. Brochures and catalogues to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment /materials being offered;

b. Outline drawings of Battery Charger and accessories showing all critical dimensions and weights, including the following:

   1. Overall dimensions;
   2. Mounting dimensions including location and size of anchor bolt holes, including base drilling plan;
   3. Plans, elevation and sectional views;
   4. Detail layout of cabinet with racks and modules;
   5. Control and power cable entrance openings at the cabinet;
   6. Details of main terminals and grounding connections;

c. Type, catalogue designation and description of major components furnished by Contractor;

d. Installation details and foundation requirements, loads, fastening details;

e. Detailed material list contained in the cabinet;

f. Terminal box and terminal blocks details and schematic diagram;

g. Detailed functional diagram, schematic diagram, panel wiring diagram, terminal block diagram and cabling layout;

h. Protection and alarm monitoring scheme;

i. General assembly and erection/installation drawings and procedures;
j. Complete design calculations;

k. Routine Tests Reports;

l. Field Tests to be performed and Field Test Reports duly signed and witnessed by NPC's representative(s);

m. List of codes used;

n. List of drawings and schedule of submittal;

o. Detailed QA Program based on ISO 9001;

p. Certified Field Test data;

q. Final Technical Data Sheets conforming to the specification;

r. Detailed Contract Schedule Activity for the equipment;

s. ISO 9001 Certification of the proposed manufacturer;

t. Complete instruction manuals for installation, maintenance and operation; and

u. As-built drawings as finally approved.

The Contractor shall provide in the manner, number of copies, and within the time set forth in the purchase order, Instruction Manuals in accordance with Section GW-2.9 of the General Works.

EW-9.0 SUBSTATION PROTECTION SYSTEM

EW-9.1 SCOPE

EW-9.1.1 General

This specification covers the technical and associated requirements for protective relay systems, relay panels, including all the various equipment and devices necessary for protection and disturbance analysis requirements of a substation(s). All materials and parts, which are not specifically mentioned herein but are necessary for the proper erection, assembly and operation of the equipment, shall be furnished at no increase in cost to the NPC.

It is neither NPC's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. The Contractor shall furnish equipment meeting the requirements of this Specification and the industry standard.

The Contractor shall bear full responsibility that the equipment has been designed and fabricated in accordance with all codes, standards and applicable governmental regulations and performs under the conditions and to the standards specified herein.

No departure shall be made from this specification and standard unless waived or modified in writing by NPC. The Contractor shall obtain from its subcontractors a statement as to compliance with this specification without exception and/or if there are any exceptions these shall be described in detail and included in Contractor's proposal. The Contractor shall add a statement that no other exceptions are taken to this specification.

EW-9.1.2 Works to be Provided by the Contractor

The Contractor shall provide the equipment; accessories and services delineated in Section B.1.0 of the Technical Data Sheets.

EW-9.1.3 Works to be Provided by NPC

NPC shall provide the materials (if any) and services listed in Section B.1.0 of the Technical Data Sheets.

EW-9.2 CODES AND STANDARDS

EW-9.2.1 General

The equipment furnished shall be in accordance with, but not limited to, the latest issues of the following applicable standards, including all addenda, in effect at time of purchase order unless otherwise stated in this specification. These shall include:

ANSI/IEEE **American National Standards Institute/or Institute of Electrical & Electronic Engineers**

C33.10	Safety Standard for Fuseholders
C33.65	Safety Standard for Cabinets and Fuseholders
C37.1	Standard Definition, Specification and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control
C37.2	Standard Electrical Power System Device Function Number
C37.90	Standard for Relays and Relay Systems Associated with Power Apparatus
C37.90.1	Standard for Surge Withstand Capability (SWC) tests for Protective Relays and Relay Systems.
C37.90.2	Standard for withstand capability of relay systems to radiated electromagnetic interference from transceivers.
C37.91 (1990)	Guide for Protective Relay Application to Power Transformer
C37.97 (1990)	Guide for Protective Relay Application to Power System Buses
C37.98 (1987)	Standard for Seismic Testing Relays
C37.99 (1990)	Guide for Protection of Shunt Capacitor Banks
C37.109 (1988)	Guide for Protection of Shunt Reactors
C37.103	Guide for differential and polarizing relay circuit testing
C37.111	Standard common format for transient data exchange (COMTRADE) for power systems
C57.13	Standard Requirements for Instrument Transformers
C57.13.1	Guide for Field Testing of Relay Current Transformers
C57.13.3	Guide for the Grounding of Instrument Transformers
Z55.1	Gray finishes for Industrial Apparatus and Equipment
8802-2, to -6	Information Technology, Local and Metropolitan Area Networks, Parts 2,3,4,5 and 6
EIA	**Electronic Industries Association**
310-C	Racks, Panels and Associated Equipment
529	Enclosure Protection
ICBO	**International Conference of Building Officials**
UBC	**Uniform Building Code, Section 2312 – Earthquake Regulations**
ICEA	**Insulated Cable Engineers Association**
S-66-524	Crossed-linked-thermosetting-polyethylene-insulated Wire and Cable for the Power and Distribution of Electrical Energy
IEC	**International Electrotechnical Commission (all parts of listed Standards apply)**
60051	Direct acting indicating analogue electrical measuring instruments and their accessories
60255	Electrical Relays
60258	Direct acting recording electrical measuring instruments and their accessories

60337	Control Switches
60359	Expression of the Performance of Electrical and Electronic Measuring Equipment
60414	Safety requirements for indicating and recording electrical measuring instruments and their accessories
60473	Dimensions for panel-mounted indicating and recording measuring instruments
60625	an interface system for programmable measuring instruments
60688	Electrical Measuring transducers for converting ac electrical quantities
60870-5-103	Interfacing
ISO	**International Standards Organization**
9001	Quality System Model for Quality Assurance in Design/ Development, Manufacture and Testing
9002	Quality System Model for Quality Assurance in Production, Installation and Servicing
SSPC	**Steel Structure Painting Council**
PA1	Shop, Field and Maintenance Painting
PA2	Measurement of Dry Paint Thickness with Magnetic Gages
UL	**Underwriters Laboratories, Inc. (all parts apply)**
44	Rubber-Insulated Wires and Cables

These codes and standards set forth minimum requirements which may be exceeded by Contractor if, in Contractor's judgment and with NPC's acceptance, superior or more economic designs or materials are available for successful and continuous operation of Contractor's equipment as required in this specification.

EW-9.3 TECHNICAL REQUIREMENTS

EW-9.3.1 Description of services

The equipment covered by this specification shall include all electrical features for complete protection and disturbance analysis of a substation and/or switchyard. The application details are in the Technical Data Sheets.

All materials and parts which are not specifically mentioned herein but are necessary for the proper erection, assembly and safe operation of the substation protection relays shall be identified and furnished by the Contractor. Any cost involved are deemed to be included in the price for substation protection relays.

EW-9.3.2 Design Requirements

EW-9.3.2.1 General

The relays shall be the rack mounted type, mounted on EIA standard 19" rack and shall be provided with panel enclosure. All of the relay targets shall be visible without opening any doors.

Where rack mounted switchboard is to be provided for the relays, it shall be mounted side by side with raceways provided for wiring to adjacent racks. The rack shall be designed for easy separation and addition of future on either side.

The relay panels shall be supplied complete with all relays, instruments, meters, indicators, control switches, push buttons, indicating lamps, terminal blocks, wiring and miscellaneous devices as called for by this Specification or indicated in the Bid drawings. The relay panel shall include all required auxiliary relays, resistors, etc., whether or not expressly called for or indicated on the bid drawings. All relay coils, contacts and other features shall be suitable for the apparatus controlled or for the purpose intended. A large number of cables will be brought in through the bottom of the relay panel and adequate provisions shall be made to accommodate, support and terminate these cables on the terminal blocks.

The relay panels shall be designed and wired with relays and devices adequate to protect not only the equipment supplied under this contract but also the future equipment shown in the single line diagram or in the substation layout.

The Contractor shall ensure that all equipment will allow sufficient room for operation, maintenance, future additions and possible future replacement of the defective components.

The Contractor shall ensure that all equipment he supplies, functions correctly and safely.

The characteristics and ratings of the equipment and devices given in the applicable sections are not necessarily the standards of any particular manufacturer but they are the minimum requirements that must be satisfied by the Contractor.

The construction of the different parts of the Supply must be as standard as possible in order to reduce to a minimum the spare parts and to make the maintenance and replacement operation easy. All similar parts must be interchangeable.

The relay panels shall be complete with grounding connection and with all accessories and shall be such as to guarantee correct and trouble free operations.

EW-9.3.3 Design and Construction Features

EW-9.3.3.1 Relay Construction and Mounting

The relay shall comply with the relevant requirements of IEC Publication 60225 or equivalent ANSI/IEEE Standard.

Modular constructed equipment (example, rack mounted solid state relaying equipment) shall be tested as a complete assembly and details of such tests shall be agreed with the NPC when details of the construction are known.

Individual relays and protection equipment intended for the panel or rack mounting shall be designed so that the internal function module(s) are capable of being removed from the case or rack without disconnecting any external wired connections. Means shall be provided to positively locate each withdrawable unit in the "service" position.

Each protection relay, or protection scheme shall be provided with an adequate number of output contacts of suitable rating to carry out the prescribed tripping functions, alarms indication and fault recorder functions and such supplementary signaling functions as may be necessary for the initiation of automatic reclosing or automatic switching control, etc. In all cases, contacts intended for tripping duty shall be designed so that they cannot inadvertently interrupt trip coil current.

For contacts intended to be used to directly energize circuit breaker tripping coils, the Contractor shall indicate the peak value of the permissible making current, and the current carrying capability for 0.5 seconds. Where appropriate, details shall also be given of the operating characteristics of any reinforcing contactor. The Contractor shall also quote the maximum breaking capability of the trip output circuit (in Amp) when associated with an inductive burden having a time constant of not less than 40ms at a rated voltage 125 volts DC and at such other voltage as may be specified for a particular installation.

All electronic protective relays shall be designed to withstand the impulse voltage and high frequency interference test requirements as specified in Clause 8, IEC Publication 60255-5 or ANSI C37.90.1 and Appendix E, IEC Publication 60255-4 or ANSI C37.90.2, respectively. The relay should also comply with IEC EMC Standards listed in Section EW-1.16.8 of the General Technical Requirements. Test frequency requirement shall be as specified in the Technical Data Sheets.

Protective relay which requires an independent low voltage DC supply shall preferably use DC/AC/DC converter power pack for this purpose. Separate power packs are preferred for each individual discriminative relay unit. This may be an integral part of the relay.

If the power pack is separately housed from the relay unit(s) which it is supplying, care must be taken that the cabling between the power pack and the relay unit and between relays units is adequately screened and physically separate from all "power type" circuits associated with the CT, VT and DC

tripping circuits. All interconnecting screened cables shall preferably be terminated by plug and sockets.

It shall not be possible to gain direct access by means of external connection to any low voltage DC power supply without first removing an appropriate protective cover suitably engrave with a warning that high voltage test shall not be applied. That is, there shall be a degree of mechanical segregation on the CT, VT and DC tripping connection and the low voltage circuits.

All input and output terminals of the power packs which are connected to "power type" circuits shall be subjected to the same over voltage, impulse and interference tests as specified for the protection. The low voltage supply to each discriminative relay unit shall be continuously monitored and an alarm shall be given whenever the voltage exceeds the limits for reliable protection operation.

Each relay, or relay scheme, shall be provided with an adequate number of indications to facilitate post fault analysis including identification of the faulted phase and faulted zone, etc. Requirements for operation indicators are as follows:

a. Long term storage of the indication is not dependent upon an auxiliary supply.

b. Means are provided to ensure that the indication is complete.

c. Each indicator, whether of the electrical or mechanical operated type, shall be capable of being reset without opening the relay case.

d. Unless otherwise approved, indication shall only be given by the protection(s), which causes the fault to be cleared.

e. All indications shall be clearly visible without opening of relay cases or relay panel doors.

Rectifiers used in association with protective relays shall preferably be of the silicon type and appropriately rated for the application.

Where relays are required to operate with accurate time settings, the delaying attachment shall not be of the dashpot type.

Wherever practicable the design of the relay schemes shall be based on the "fail-safe" principle. For example, care shall be taken to ensure that the loss of DC supply or an open circuit does not cause incorrect opening or closing of a circuit breaker. Circuit breaker or isolator repeat relays should be of the latching type and a discrepancy alarm shall be provided to check correct operation of the relays following a circuit breaker or isolator operation.

Lockout tripping relays shall be of the latching type and shall be hand or electrically reset as specified.

Numerical relays must be provided by at least two serial interfaces according to IEC 60870-5-103.

EW-9.3.4 Substation Protection Requirements

EW-9.3.4.1 General

The protection system for the substation protection shall be as stated in the Technical Data Sheets. Depending on the requirements and importance of the equipment protected, the protection system may consist of one, two or more completely independent sets.

Where two of more protection sets have been specified in the Technical Data Sheets, they shall be fully independent of each other and shall be located in separate cubicles and shall be made preferably by different manufacturers, unless otherwise indicated in the Technical Data Sheets.

In addition to the basic function of the relays, supplementary and back-up protective functions shall also be provided in this specification and in the Technical Data Sheets.

All protective relays shall be of numerical design.

The relay design shall include extensive automatic self-checking facilities to supervise and monitor the condition of the individual processors, measuring elements, DC supply, etc. Any abnormal condition detected shall initiate an alarm and indicate the defective element. Defects that may cause mis-operation of the relay shall inhibit operation of that particular relay or element of a relay system. Less critical defects may initiate an alarm only.

Where voltage inputs are required, these shall be monitored continuously. Any open phase shall be detected high speed and shall prevent mis-operation of the affected protective relays. Unbalanced conditions in the current circuits due to defective connections should also be monitored.

Test facilities shall also be provided for each equipment.

EW-9.3.4.2 Relay Performance Requirements under CT Saturation/CVT Transients

The protective relay system shall operate correctly in the presence of simultaneous CVT transients and CT saturation.

Current Transformers. The protection shall operate correctly and within the required operating speed even when the CTs supplying current to it saturate completely one cycle after fault inception. When two circuit breakers control a line, Contractor shall ensure that when one of the CTs saturates for any external fault at the bus or other circuits, mis-operation of the relay shall not occur.

Capacitor Voltage Transformers. The relay system shall operate correctly and with high speed and shall have correct directional sensing in the presence of severe CVT transients produced in accordance with ANSI Standard C93.2 or IEC equivalent. The CVT transient requirement shall include the conditions of relaying accuracy with the rated burden of the CVT connected. The relay response to CVT transients shall be demonstrated during model power system testing.

The relay contractor shall ensure that the relay system being furnished shall operate satisfactorily with the instrument transformers to which they will be connected. The relay contractor shall coordinate with the instrument transformer manufacturer in making sure that the CT and CVT characteristics satisfy the protection requirements for all conditions, including CT remanence, high-speed autoreclosing and allowing for some future system expansions. The relay contractor shall provide the NPC with copies of any coordination correspondences with the instrument transformer manufacturer or calculation to prove that the relay requirements will be met. CT's or CVT's that are found to be unsuitable, as a result of failure of the relay manufacturer to coordinate his requirements, must be replaced by the relay contractor at no cost to the NPC.

EW-9.3.4.3 Relay System Security, Dependability and Speed

The relay system shall meet basic security, dependability and speed requirements described below.

Security. The relay system shall be very secure. The consideration for selection of the relay system will place much emphasis on the security of the relay system. Any false trip output cannot be tolerated due to the difficulties that would arise with more than one Power line out of service. The security of the relay system shall be demonstrated on model system tests as discussed in Section EW-9.5.1.2. The relay shall not commit maloperation with any of the following conditions:

a. Any kind of external faults beyond the protected sections

b. Transient system disturbances

c. Current surges due to sudden change of line charging capacity in the case of one phase to ground fault, line switching on external faults, etc.

d. DC components of short circuit currents

e. Magnetic fields from other relays

f. Normal discharges of arresters installed in the protected sections.

The operating time of the relay system shall conform to the operating time listed in the Technical Data Sheets.

Dependability. The relay system shall be highly dependable. The relay system shall produce a trip output for all types of faults within the zone of protection. The dependability of the relay system shall be demonstrated through conjunctive model system tests as discussed in Section EW-9.5.1.2.

EW-9.3.4.4 Relay System Disabling

A master disabling switch or equivalent features shall be supplied for the purposes of completely disabling the relay system. The features shall include the following:

a. Open all relay system trip outputs

b. Open all potential supplies to the relay system

c. Short circuit current transformer secondaries before opening all current circuits to the relay system

d. Energize a substation annunciator lamp

e. Input to the station sequence of events recorder

f. Disable all relay system outputs such as breaker fail initiate, reclose initiate, reclose block, out of step trip, transfer trip, etc.

EW-9.3.4.5 Transient Protection

The Contractor shall provide adequate surge protection on all current, voltage and DC control leads entering a panel or rack in order to mitigate induced voltages and currents and prevent equipment malfunction or damage. The relay system shall be capable of passing the ANSI/IEEE C37.90 or equivalent IEC Standard surge withstand capability test.

Appropriate wire and cable shielding, twisted wire pairs, separate power and signal grounds and wire routing shall be applied to mitigate induced voltages and currents.

The equipment shall not be damaged or produce a false output with radio frequencies, from 25 to 500 MHz and a field strength of 7 volts/meter measured at the front of the relay case, applied with the relays energized and connected for normal operation.

EW-9.3.5 Power Transformer Protection Requirements

EW-9.3.5.1 General

Depending on the requirements as indicated in the Technical Data Sheets, the protection system for the power transformer may consist of either one or two completely separate protection sets, Main 1 and Main 2. These two protection sets shall be fully independent of each other and shall be located in separate cubicles, unless otherwise indicated in the Technical Data Sheets. The composition of the two protection sets, if two separate protection cubicles are required, is indicated in the Technical Data Sheets.

If the transformer protection is required to be a part of the microprocessor-based substation control and protection system, the relay shall be a full numerical protection relay which shall have an integrated overcurrent, overvoltage (if required), restricted earth fault protection and thermal overload protection function.

EW-9.3.5.2 Transformer Differential Relay

The relays shall be of numerical type capable of three phase tripping.

Depending on the requirement stated on the Technical Data Sheets, the differential relay can be of the type using:

a. Percentage differential with harmonic restraint; or

b. Voltage operated bus type high impedance differential relay.

Differential protection using percentage differential with harmonic restraint shall have the following basic functions as a minimum:

a. Relays shall include harmonic restrained circuits to prevent undesired tripping on exciting inrush.

b. Relays shall include separate restraint circuits to be associated with each breaker current input source.

c. Relays shall include percentage differential characteristic to allow for individual CT errors.

d. Relays shall include instantaneous differential overcurrent element for high-speed trip on high fault currents.

e. The zone of protection shall include transformers, transformer leads, and transformer circuit breakers.

f. The relays shall include provision for CT ratio matching with values specified in the Technical Data Sheets to permit use of different CT ratios. These shall be by means of taps on relays, auxiliary CT's, or numerical methods.

g. The relays shall include targets and output contacts for tripping the lockout relay.

h. Relay operating time shall be as specified in the Technical Data Sheets.

Differential protection using voltage operated bus type high impedance relay shall have the following basic functions as a minimum:

a. Relays shall include high impedance voltage element differentially connected to CT's, to detect all types of phase faults and ground faults.

b. Relays shall include instantaneous overcurrent elements for high speed trip for high fault current.

c. The relays shall include targets and output contacts for tripping the lockout relay.

d. Relay operating speed shall be as specified in the Technical Data Sheets.

EW-9.3.5.3 Individual Transformer Single Phase Unit Differential Relays

Where transformer shall consist of single-phase banks to form a three-phase unit, an individual transformer single phase unit differential relay shall be provided having functions similar to those described in Section EW-9.3.5.2, except that the zone of protection shall be limited up to the transformer bushings.

EW-9.3.5.4 Transformer High Voltage Side Leads Differential Relays (If Required)

This type of relay is required only for single phase unit transformer bank and shall be of type specified in the Technical Data Sheets with the zone of protection up to the high voltage leads and high voltage breakers.

EW-9.3.5.5 Transformer Low Voltage Side Leads Differential Relays (If Required)

This type of relay is also required for single phase unit transformer bank with functions similar to those described in Section EW-9.3.5.4, except that the zone of protection shall include low voltage leads and low voltage breakers.

EW-9.3.5.6 Over excitation/Over fluxing (Excessive Volts/Hz) Relay (If Required)

This shall be of numerical type capable of three phase tripping and shall have the following basic functions as a minimum:

a. Relay shall include volts/Hz sensing unit to detect over excitation. Preference will be given to schemes in which the operating time decreases with increase in voltage or v/Hz so as to match the overheating characteristics of the protected equipment.

b. Relay shall include timing unit to provide selectable inverse time and definite minimum time characteristic for backup tripping on excessive volts/Hz. The setting shall be adjustable within the range which best guarantees safe protection of the primary equipment.

c. Relay shall include stage 1 contact for alarm and stage 2 contacts for tripping the lockout relay. Targets shall be provided.

d. The voltage circuit shall be designed with an adequate factor of safety to withstand the anticipated overvoltage without damage to the relay and without saturation of the relay circuit.

EW-9.3.5.7 Transformer Overcurrent Relays

Transformer overcurrent relays shall include as a minimum:

a. Phase instantaneous overcurrent (50) and phase time overcurrent (51) applied on the high voltage side of the transformer;

b. Instantaneous neutral overcurrent (50N) and time neutral overcurrent (51N) relay applied on the high voltage side of the transformer connected on neutral for back-up protection;

c. Phase time (51) and ground overcurrent (51G) functions applied on the tertiary side of the transformer for back-up protection;

d. Phase instantaneous overcurrent, phase time overcurrent and ground overcurrent time delayed relay applied on the low voltage side of the transformer, if required.

The overcurrent relay shall be numerical type capable of three phase tripping and shall include the following features as a minimum:

a. The overcurrent relay shall have a self-supervision system that continuously monitors/ supervises the function of the microprocessors and the program execution;

b. The overcurrent time characteristics shall be programmable so that it shall be possible to field select definite time, IEC normal inverse, very inverse or extremely inverse characteristics, or equivalent US moderately inverse, inverse, very inverse, or extremely inverse characteristics. It shall be possible to field select the characteristics for phase units independently and different from the ground relay.

c. Overcurrent relays shall include output contacts for tripping the associated breakers directly and for use in substation alarms and event recorders.

d. The overcurrent relays shall be made insensitive to harmonics by use of proper filtering techniques.

e. Overcurrent relays shall include a test switch.

f. Overcurrent relay current setting ranges and parameters shall be as stated in the Technical Data Sheets.

Where directional overcurrent and directional earth fault protection is specified, the following additional requirements are required:

a. The operating time of the directional element shall have negligible influence on the total operating time of the protection;

b. The directional overcurrent and earth fault protection shall operate as a non-directional protection if the directional elements fail to function for any reason (i.e. loss of VT voltage, directional element removed, etc.).

Where voltage controlled overcurrent protection is specified, the minimum operating current at any setting at zero voltage shall not be less than 25 percent of the operating current at 100 percent voltage at the same setting.

EW-9.3.5.8 Neutral Current Protection

Earth fault protection in two steps shall be installed in the transformer neutral. Operating speed and setting range shall be as specified in the Technical Data Sheets. The time delayed elements shall be field selectable to the

applications required characteristics: definite time, normal inverse, very inverse, or extremely inverse.

EW-9.3.5.9 Restricted Earth Fault Differential Relay

A high impedance current operated function shall be provided for the high and low voltage side of the transformer with grounded neutral point as required in the Technical Data Sheets. The relay shall remain stable for external faults. The current function shall not be sensitive to harmonics. Operating speed and setting range shall be as specified in the Technical Data Sheets.

EW-9.3.5.10 Lockout Relay

The protection panel shall include a multi-contact lockout relay, selectable manual or electrical reset button on the front of the relay, with sufficient contacts for tripping, close blocking, reclose blocking, breaker failure initiation of the transformer breakers. Contacts for alarm, recorder, remote alarms, etc. shall be included.

If two protection sets are required for the transformer protection, each protection set or cubicle shall have an independent lockout relay equipment.

Operating parameters of the lockout relay shall be as stated in the Technical Data Sheets.

EW-9.3.5.11 Repeat Relays for Mechanical and Electrical Relays Associated with the Transformer

The gas accumulator (Buchholz) relay, sudden pressure (gas and oil) relay, temperature (winding and oil) relay, oil level and faulty cooling equipment relay are the mechanical and electrical relays associated with the protection of the transformer, each having a trip contact operating a trip relay directly. For local and remote alarms of these relays, repeat relays shall be provided and connected to each of the transformer protection trip device and the trip relay. These repeat relay shall have sufficient contacts for all remote alarm and indication functions.

The number of repeat relays required will depend upon the number of transformer protection devices, details of which shall be coordinated by the Contractor of the protection devices with the transformer manufacturer.

EW-9.3.5.12 Overvoltage Protection

Overvoltage protection, if required for the transformer protection, shall be of microprocessor based design or numerical type capable of three phase tripping and shall include the following basic functions as a minimum:

a. The protection shall monitor one or more of the phase voltages and tripping shall occur when the phase voltages exceed the setting in time to prevent damage to the transformer due to extreme high voltage conditions.

b. The setting shall be adjustable within the range with best guarantees safe protection of the reactor.

c. The relay shall have two steps, one for alarm and one for trip.

d. The voltage circuit shall be designed with an adequate factor of safety to withstand the anticipated overvoltage without damage to the relay and without saturation of the relay circuit.

EW-9.3.5.13 Transformer Tertiary Winding Protection, if Applicable

Protection against phase faults where the overall transformer differential protection may lack sensitivity, shall be provided by an overcurrent relay driven from tertiary BCT's. The relay shall be in accordance with Section EW-9.3.5.7 but without 50N/51N. The CT's for this protection shall be connected in Delta.

Protection against earth faults shall be provided by a neutral voltage displacement relay driven from a broken Delta secondary winding of a medium voltage VT connected to the tertiary bus connection. An anti-ferroresonance loading resistor shall also be applied. The relay shall be in accordance with Section EW-9.3.5.12 but with appropriate setting range and insensitivity to 3rd harmonic voltage.

EW-9.3.6 Shunt Reactor Protection Requirements

EW-9.3.6.1 General

Depending on the requirements as indicated in the Technical Data Sheets, the protection system for the shunt reactors may consist of either one or two completely separate protection sets, Main 1 and Main 2. These two protection sets shall be fully independent of each other and shall be located in separate cubicles, unless otherwise indicated. The composition of the two protection sets, if two separate protection cubicles are required, is indicated in the Technical Data Sheets.

If the shunt reactor is required to be a part of the microprocessor-based substation control and protection system, preference will be given to a numerical protection relay which shall have an integrated overcurrent, overvoltage, overfluxing, restricted earth fault (if required) and all other necessary relays including thermal overload protection function to act as a back-up function for the differential protection.

EW-9.3.6.2 Differential Relay

The relays shall be of numerical type capable of three phase tripping.

Depending on the requirement as stated on the Technical Data Sheets, the differential relay can be of the type using:

a. Percentage differential; or

b. Voltage operated bus type high impedance differential relay.

Differential protection using percentage differential shall have the following basic functions as a minimum:

a. Relays shall include separate restraint circuits to be associated with each breaker current input source.
b. Relays shall include percentage differential characteristic to allow the individual CT errors.

c. Relays shall include instantaneous differential overcurrent element for high speed trip on high fault currents.

d. The zone of protection shall include reactors, reactor leads and reactor circuit breakers.

e. The relays shall include targets and output contacts for tripping the lockout relay.

f. Relay operating time shall be as specified in the Technical Data Sheets.

Differential protection using voltage operated bus type high impedance relay shall have the following basic functions as a minimum:

a. Relays shall include high impedance voltage element differentially connected to CT's, to detect all types of phase faults and ground faults.

b. Relays shall include instantaneous overcurrent elements for high speed trip for high fault current.

c. The relays shall include targets and output contacts for tripping the lockout relay.

d. Relay operating speed shall be as specified in the Technical Data Sheets.

EW-9.3.6.3 Restricted Earth Fault Differential Relay

A high impedance current operated function shall be provided for the reactor as required in the Technical Data Sheets. The relay shall remain stable for external faults. The current function shall not be sensitive to harmonics. Operating speed and setting range shall be as specified in the Technical Data Sheets.

EW-9.3.6.4 Reactor Overcurrent Relays

Reactor overcurrent relays shall include as a minimum, phase instantaneous overcurrent (50), phase time overcurrent (51) and ground time overcurrent (51N) functions.

The overcurrent relay shall be of microprocessor based design or numerical type capable of three phase tripping and shall include the following features as a minimum:

a. The overcurrent relay shall have a self-supervisions system that continuously monitors/ supervises the function of the microprocessors and the program execution;

b. The overcurrent time delayed characteristics shall be programmable so that it shall be possible to field select definite time, IEC normal inverse, very inverse or extremely inverse characteristics, or equivalent US moderately inverse, inverse, very inverse, or extremely inverse characteristics. It shall be possible to field select the characteristics for phase units independently and different from the ground relay.

c. Overcurrent relays shall include output contacts for tripping two breakers directly and for use in substation alarms and event recorders.

d. The overcurrent relays shall be made insensitive to harmonics by use of proper filtering techniques.

e. Overcurrent relays shall include a test switch.

f. Overcurrent relay current setting ranges and parameters shall be as stated in the Technical Data Sheets.

EW-9.3.6.5 Overvoltage Relay

Overvoltage protection, if required for the shunt reactor protection, shall be of microprocessor based design or numerical type capable of three phase tripping and shall include the following basic functions as a minimum:

a. The protection shall monitor one or more of the phase voltages and tripping shall occur when the phase voltages exceed the setting in time to prevent damage to the reactor due to extreme high voltage conditions. (Note: Disconnection of the reactor from service shall coincide with the de-energization of the associated Power line for line connected reactor).

b. The setting shall be adjustable within the range with best guarantees safe protection of the reactor.

c. The relay shall have two steps, one for alarm and one for trip.

d. The voltage circuit shall be designed with an adequate factor of safety to withstand the anticipated overvoltage without damage to the relay and without saturation of the relay circuit.

EW-9.3.6.6 Neutral Current Protection

Earth fault protection in two steps shall be installed in the reactor neutral. Operating speed and setting range shall be as specified in the Technical Data Sheets. The time delayed elements shall be field selectable to the applications required characteristics: definite time, normal inverse, very inverse, or extremely inverse.

EW-9.3.6.7 Lockout Relay

The protection panel shall include a multi-contact lockout relay, selectable manual or electrical reset button on the front of the relay panel, with sufficient contacts for tripping, close blocking, and reclose blocking, breaker failure initiation of the transformer breakers. Contacts for alarm, recorder, remote alarms, etc. shall also be included.

If two protection sets are required for the reactor protection, each protection set or cubicle shall have independent lockout relay equipment.

Operating parameters of the lockout relay shall be as stated in the Technical Data Sheets.

EW-9.3.6.8 Repeat Relays for Mechanical and Electrical Relays Associated with the Reactor

The gas accumulator (Buchholz) relay, sudden pressure (gas and oil) relay, temperature (winding and oil) relay, oil level and faulty cooling equipment relay are the mechanical and electrical relays associated with the protection of the reactor, each having a trip contact operating a trip relay directly. For local and remote alarms of these relays, repeat relays shall be provided and connected to each of the reactor protection trip device and the trip relay. These repeat relay shall have sufficient contacts for all remote alarm and indication functions.

The number of repeat relays required will depend upon the number of reactor protection devices, details of which shall be coordinated by the Contractor of the protection devices with the reactor manufacturer.

EW-9.3.7 Shunt Capacitor Protection Requirements

EW-9.3.7.1 General

Depending on the requirements as indicated in the Technical Data Sheets, the protection system for the shunt capacitors may consist of either one or two completely separate protection sets, Main 1 and Main 2. These two protection sets shall be fully independent of each other and shall be located in separate cubicles, unless otherwise indicated. The composition of the two protection sets, if two separate protection cubicles are required, is indicated in the Technical Data Sheets.

EW-9.3.7.2 Shunt Capacitor Overcurrent Relays

Shunt capacitor overcurrent relays shall include as a minimum, phase instantaneous overcurrent (50), phase time overcurrent (51) and ground time overcurrent (51N) functions.

The overcurrent relay shall be of microprocessor based design or numerical type capable of three phase tripping and shall include the following features as a minimum:

a. The overcurrent relay shall have a self-supervisions system that continuously monitors/ supervises the function of the microprocessors and the program execution;

b. The overcurrent time delayed characteristics shall be programmable so that it shall be possible to field select definite time, IEC normal inverse, very inverse or extremely inverse characteristics, or equivalent US moderately inverse, inverse, very inverse, or extremely inverse characteristics. It shall be possible to field select the characteristics for phase units independently and different from the ground relay.

c. Overcurrent relays shall include output contacts for tripping two breakers directly and for use in substation alarms and event recorders.

d. The overcurrent relays shall be made insensitive to harmonics by use of proper filtering techniques.

e. Overcurrent relays shall include a test switch.

f. Overcurrent relay current setting ranges and parameters shall be as stated in the Technical Data Sheets.

EW-9.3.7.3 Overvoltage Relay (Unbalance Protection)

The relay shall be of microprocessor-based design or numerical type capable of three phase tripping and shall include the following basic features as a minimum (from ANSI/IEEE C37.99 – 1990 Paragraph 7.3):

a. Relay shall include phase overvoltage functions with adjustable time delays of definite minimum time characteristics. Overvoltage settings shall be as specified in the Technical Data Sheets.

b. The relay should be coordinated with individual capacitor unit fuses such that the fuses will operate to isolate a defective capacitor unit before the bank is switched out of service, and thus provide a convenient visual means of locating the defective capacitor unit.

c. Where possible, the relay should be sensitive enough to alarm for the loss of one unit within a group and trip and lockout on loss of sufficient or additional capacitor units that will cause a group overvoltage condition in excess of 110% of rated voltage.

d. The relay should have a time delay short enough to minimize damage due to an arcing fault within the bank structure, and prevent exposure of the remaining capacitor units to overvoltage conditions beyond their permissible limits. The time delay should also be short enough to avoid damage to the current transformer or voltage transformer and relay system, for a single phase or an open-phase condition.

e. The relay should have a time delay sufficient to avoid false operations due to inrush, ground faults on the line, lightning, switching of nearby equipment, and non-simultaneous pole operation of the energizing switch.

f. The relay should be protected against transient voltages appearing on the control wiring (see ANSI/IEEE C37.90-1989 [6]).

g. The relay should be provided with filter to minimize the effect of harmonic voltages.

h. The relay scheme should have a lockout feature to prevent automatic reclosing of the capacitor bank switching device in the event that an overvoltage trip has occurred. The relay trip circuit components should be coordinated.

i. Other features specified in ANSI/IEEE C37.99 – 1990 Paragraph 7.3 should be considered in the application of this relay.

EW-9.3.7.4 Capacitor Bank Breaker Failure Protection

If the capacitor bank is connected to the bus by a circuit breaker, a breaker failure scheme shall be provided to remove the capacitor bank from the system in the event that the bank's switching device fails to operated correctly for a fault within the capacitor bank. Technical features and characteristics shall be as stated in Section EW-9.3.9.

EW-9.3.7.5 Undervoltage Relay (Loss of Bus Voltage: ANSI/IEEE C37.99 - 1990 [8.5])

The relay, if required shall be connected to the bus VT and shall detect the loss of supply bus voltage tripping the capacitor switching device. Tripping of the relay shall be timed delayed to prevent de-energization of the bank for transient undervoltage conditions which might occur when a source-side switching device operates to clear a fault and then automatically recloses.

The relay should be set such that the relay will not operate for voltages that require the capacitor bank to be placed in service.

EW-9.3.8 Breaker Failure Protection Requirements

EW-9.3.8.1 General

To provide fast back-up protection in case a circuit breaker fails to open when ordered to trip by a protective relay, breaker failure relays shall be provided for each of the breakers as shown in the One Line Diagram. These relays shall be enclosed in a free-standing control cubicle similar to that of other relays. The name of the breaker shall be marked on the relay.

The BF relay functional and technical specification is described below:

The BF relay shall be applicable for use with both three-pole and single-pole tripping schemes. It shall be provided with three current detectors connected to the three-phase currents.

The circuit breaker failure relay shall be activated when the primary relays associated with the protected circuit breaker close their contacts and initiate the trip command to the corresponding circuit breakers. Successful tripping of the circuit breakers by the primary relay will automatically reset the BFR

before the time relay of the BFR elapses. If the tripping fails, with the fault current still flowing after a predetermined time, a trip command shall be issued to the circuit breakers that must be opened to isolate the fault including provisions for transfer trip command to adjacent stations.

The BF relay shall be provided with a contact (per phase) to re-trip the primary circuit breaker, via separate wires to the second trip coil.

The design of the relay shall ensure that accurate and consistent timing shall always be achieved under all conditions. Current detectors shall not cause contact disturbances during adverse CT saturation independent of current magnitude and possible dc components. Breaker-fail current detector relays should not be driven from CT's which are also used to drive any high-impedance differential protection, since such CT's may become heavily saturated for in-zone fault conditions. This may impair correct operation of breaker fail current detector in the event of breaker failure to clear a fault within the zone of differential protection.
Also for reliable timing in case of contact bounce of the primary protection relay, seal-in of the breaker failure initiation signal shall be provided.

The BF relay shall be provided with initiation inputs as follows:

a. Per phase initiation for use with single pole tripping schemes.

b. Three phase initiation for use with three pole tripping schemes.

c. Initiation from non-current-operated detection relays (such as Buchholz relay) which shall use the circuit breaker 52a contacts in addition to the current detector as a decision criterion.

BF relay shall be designed to make it secure from unnecessary operation:

a. In case of accidental earth faults in the auxiliary voltage supply circuits.

b. The BF trip relay shall be actuated through an AND circuit from to different channels – the BF logic and BF initiating signal.

c. The output of the BF logic shall be continuously monitored and an alarm given in case a defect is found. If the defect could lead to potential mal-operation, tripping shall be blocked.

The BF relay unit setting ranges and parameters shall be as stated in the Technical Data Sheets. The BF relay unit shall be provided with an accurate timer with a setting range specified in the Technical Data Sheets.

The current detectors shall have a sufficiently wide setting range of at least 0.5A – 10A at 60 Hz in steps of 0.5A.

For the traditional BF scheme which relies on the reset of the current detectors, the reset time shall not be more than what is specified in the Technical Data Sheets. For the BF scheme which relies on the operation of the current detector to start the timer, the pick-up time shall not be more than what is specified in the Technical Data Sheets.

Each BF relay unit shall be provided with its own test switch to allow complete secondary injection and timing tests on the relay. During testing, the CT circuit shall be shorted and the tripping and output signals to the breaker and other BF units shall be opened automatically when the test position is selected or the test plug is mounted. The test facilities shall provide means for injecting currents, input signals, and monitoring all output points.

Initiate and Output/Tripping Logic

a. The BF Protection System shall be provided with the necessary auxiliaries to trip the failed breaker and the adjacent or back-up circuit breakers. For tripping of the bus breakers at least six (6) extra unused contacts shall be provided. It shall be possible to route the trip signal from the bus differential relay for tripping the bus breakers.

b. A hand-reset lock out relay shall be provided to prevent manual closing of the failed circuit breaker and the adjacent circuit breakers. Extra contacts shall also be provided for future use to block closing of the additional breakers in the future.

c. Breaker failure protection and tripping of back-up breakers shall give an alarm and local indications of the failed circuit breaker and adjacent breakers.

d. Breaker fail operation shall also be provided with contacts for use with direct transfer trip of the remote line end breakers, for event recording equipment and to block auto-reclosing.

The BFR shall be provided with a miniature circuit breaker control for the dc supply for each panel.

EW-9.3.8.2 CT Column Short-Zone Fault Protection (for live-tank breakers with CTs on one side only)

Protective relays shall be provided for detection and high-speed clearing of any fault between a circuit breaker and its associated CT column.

When a circuit breaker is open or is tripped, any fault between the circuit breaker and its associated current transformer shall be cleared high-speed.

The short-zone fault (SZF) protection shall be activated, after a short time delay, when the circuit breaker starts to open. Provide a timer (setting range of 20 ms to 200 ms in 10 ms steps) for each phase (when used with single pole-reclosing), which shall be started by the circuit breaker contact opening. When the circuit breaker is in the closed position the protection shall be de-activated.

Tripping may only occur when the following conditions are satisfied simultaneously:

a. The protection is activated

b. Current continues to flow after the breaker is open

c. The line, transformer, or bus protective relays have remained in their operated state.

This protective system may be part of the breaker fail protection but shall clear the fault high-speed and not through the breaker fail timer. The timer for activation of the short-zone protection shall be different from that of the breaker fail protection.

The tripping outputs of the short-zone protection may be the common to that of breaker fail protection; however, indication shall be given for short-zone fault and not breaker failure.

EW-9.3.9 Feeder Protection

EW-9.3.9.1 General

The principle of the feeder protection system is shown in the single line diagram. It shall be a complete and integrated protection for the feeder, the bus and overhead feeders in solidly-grounded networks.

The protection system shall employ modern microprocessor-based design preferably using numerical methods. Extensive self-checking and continuous monitoring function shall be provided to ensure security.

The relays shall be made insensitive to harmonics by use of proper filtering techniques.

Depending on the requirement specified in the Technical Data Sheet, the protection shall consist of phase and ground time and instantaneous overcurrent relays, directional phase and ground relays (if required) and reclosing relays (if required). Other relays such as bus protection relays, differential relays and features such as breaker failure functions, fault recording functions and metering may be included, if required in the Technical Data Sheets.

Alarm and signaling facilities and a test switch at least for each group of relays for every feeder or for each individual relay shall be provided.

EW-9.3.9.2 Overcurrent Relay

The overcurrent relay shall consist of three phase units and a ground unit. Each unit shall have an instantaneous element and a time delayed element.

The overcurrent time delayed characteristics shall be programmable so that it shall be possible to field select definite time, IEC normal inverse, very inverse or extremely inverse characteristics or equivalent US moderately inverse, inverse, very inverse or extremely inverse characteristics for phase units independently and different from the ground relay.

Each overcurrent unit shall be capable of being controlled independently by a directional relay through an input on the overcurrent unit. Overcurrent relays with built-in directional elements are also acceptable. The directional relays shall have the features described in Section EW-9.3.10.3.

Overcurrent relays shall include output contacts for tripping the associated breakers and for use in the substation alarms and event recorders.

Overcurrent relay setting ranges and parameters shall be as stated in the Technical Data Sheets.

The overcurrent relay, if required in the Technical Data Sheets, shall be provided with built-in fault and event recorder. It shall record all the analog voltage and current inputs as well as the operation of the output relays and the control inputs. The relay shall be able to store the last three fault records. The required software and other hardware needed to connect to a standard portable computer to access and analyze the recorded information shall be supplied.

EW-9.3.9.3 Directional Relay

The directional relay, when specified in Bid Drawings and the Technical Data Sheets, shall be used to control the directionality of the overcurrent relays described above. The directional relay may be a separate unit or may be an integral part of the overcurrent relay.

The directional relay shall include three phase and one ground directional elements, if specified in the Bid Drawings and Technical Data Sheets. Each individual directional unit shall have an output contact for controlling the operation of the overcurrent relay.

Each overcurrent units shall have an instantaneous element and a time delayed element. The overcurrent relay should also include an overload element to monitor the line load and provide an alarm when the load exceeds a preset level for some time.

The relay shall be programmable so that is shall be possible to field select definite time, IEC normal inverse, very inverse or extremely inverse characteristics or equivalent US moderately inverse, inverse, very inverse or extremely inverse characteristics. It shall be possible to field select the characteristics for phase units independently and different from the ground relay.

The directional characteristic angle setting for the ground element shall be separate from that of the phase elements.

The relay setting ranges and parameters shall be as listed in the Technical Data Sheets.

For the phase directional units, the operational quantity shall be three phase current and the polarizing voltage shall be the non-faulted phase-to-phase voltage which is in quadrature with the current under unity power conditions, the current leading the polarizing voltage by 90°. Maximum sensitivity shall

occur when the current leads the polarizing voltage by about 45° or 30° (field selectable). This is equivalent to the current lagging the system phase-to-neutral voltage by 45°C or 60°C.

For the ground directional unit, the operating quantity shall be the residual line current and the polarizing quantity shall be derived from the residual voltage of the line. The maximum sensitivity shall occur when the residual current lags the residual voltage by about 60°.

The relay shall also include metering facilities with numerical read-out for amperes, voltage, watts, vars, and power factor. The relay shall be provided with a built-in fault and events recorder. It shall record all the analog voltage and current waveform inputs as well as the operation of the output relays and the control inputs. The relay shall be able to the last three fault records.

Interfacing with the relay for settings, reading alarms and event data shall be performed locally with a built-in keypad and by a local PC. It shall also possible to communicate with the relay remotely, via a personal computer with a software, to read data, view or change settings and configuration, and retrieve fault information. The required software and other hardware that are needed to connect to a communication modem and a standard computer to access and analyze graphically the recorded information shall be supplied.

The directional relay shall include output contacts for tripping the associated breakers and for use in the substation alarms and event recorders.

Provide a test switch for the directional relay. This switch may be common with that of the overcurrent relay.

EW-9.3.9.4 Reclosing Relay

When specified in the Bid Drawings and Technical Data Sheet, each feeder shall be provided with a reclosing relay which shall have a programmable auto-reclose sequence to be able to coordinate the instantaneous and time delayed characteristics of the feeder overcurrent relay with the downstream fuses and reclose on the protected circuit.

The autoreclosure unit shall receive its start commands from the instantaneous and time delayed units of the feeder overcurrent phase and ground relay. The starting signal determines whether a high speed or delayed reclosures and time delays required for each reclosure, until a final tripping is made. Consummation of the pre-defined autoreclosure program or sequence shall cause the relay to lockout until the reclaim time has elapsed.

It shall have at least three programmable reclosing shots (one high speed auto-reclose and one to two delayed auto-reclosures) with adjustable dead times specified in the Technical Data Sheets. A trip fail timer shall be provided which starts when the recloser is started and causes the relay to go into lockout if the start input stays on for the duration of the preset trip fail time. The relay shall also have a reset timer which allows the relay to reset from lockout after a successful manual close of the circuit breaker. The reset time shall also be started after the final dead time following successful autoreclosing.

The reclosing relay shall be provided with at least the following inputs:

a. Enable or disable autorecloser from a switch
b. Breaker status via 52a or 52b contact
c. Start by overcurrent protection
d. Start by instantaneous protection
e. Cancel or block autoreclosing and the lockout relay
f. Reset the relay from lockout

The reclosing relay shall be provided with at least the following outputs:

a. Close circuit breaker
b. Autoreclosing in progress
c. Block Instantaneous Overcurrent trip
d. Circuit breaker failed to close
e. Recloser out of service

The recloser shall be provided with counters to count the number of successful first shots, second shots and third shots and the total number of unsuccessful shots.

Each feeder protection, if required in the Technical Data Sheets shall include a breaker failure protection function to provide a faster tripping of the main feeder. This function may be a separate unit or could be a built-in function of the overcurrent relay. The breaker fail function shall be initiated by any overcurrent trip to start a timer. When the breaker fails to open and isolate the fault, the breaker fail protection will trip the adjacent breakers after a preset time delay if the protective relay remains operated and also after checking that the current flowing through the breaker is still above a preset current level. If any of these conditions is not satisfied the breaker fail function resets and does not trip the backup breakers.

The protection system shall also provide protection for faults on the 69 kV bus that is fast enough to operate with 100ms. Schemes using the feeder relays or a separate differential relay to provide this protection will be acceptable. The tenderer shall provide details of the scheme offered.

EW-9.3.10 Monitoring and Metering Requirements

The supplied Digital Multifunction Meter shall be able to display the most critical measurements in the mains-power equipment: voltage, amperage, active power (watts) and power factor.

The Digital Multifunction Meter should have the following minimum required capabilities and features:

1. Current cumulative (kVAR),
2. Energy delivered/ received (kWh)
3. Reactive energy delivered (kVARh)
4. Instantaneous power (kW)
5. Maximum demand (kW)
6. Voltage (V)
7. Current (A)

8. Frequency
9. Power factor

EW-9.3.11 Other Technical Requirements

Other features for the Substation Protection Relays, if required by the NPC are stated in the Technical Data Sheets.

EW-9.4 INSTALLATION

Installation will be by Contractor unless specified otherwise in Section B.1.0 of the Technical Data Sheets.

When the installation is by Contractor, such as for turn-key contracts complete details of proper handling, storage and transport, installation, testing and commissioning, performance, guarantees, etc. shall be submitted for NPC's review and approval.

EW-9.5 FACTORY ASSEMBLY AND TESTS

EW-9.5.1 Type Tests

EW-9.5.1.1 General

The Contractor shall perform a comprehensive type test on the prototype of the relays to confirm the adequacy of its design and the protection techniques. This test shall include all the necessary tests stipulated in IEC Publication 60255 (all applicable sections), ANSI Std. C37.90 and C37.90a and other standard tests done by the manufacturer, such as the following: power frequency, impulse, high frequency interference, surge withstand capability, spark test, thermal capability, temperature dependency, temperature rise, static accuracy, power consumption, phase selection, dynamic accuracy, distance measurement, directional measurement, operating characteristics and others.

EW-9.5.1.2 Type Tests Report

The Contractor shall submit six (6) certified copies of the results of type tests on each type of equipment to be supplied to show the adequacy of its design.

EW-9.5.2 Routine Tests

These tests shall include material tests during manufacture as per manufacturer's established practice and/or other approved standards. However, on electronic equipment, individual component tests and burn-in tests of important modules (temperature and voltage stress) shall be performed.

Routine testing shall be performed following the requirements of ANSI C37.90 and C37.20 or IEC equivalent and shall include but are not limited to the following:

a. Dielectric (power frequency) test

b. Mechanical operation test
c. Grounding of instrument transformer cases
d. control wiring continuity test
e. polarity test
f. Functional test
g. Compliance tests (demonstrating compliance with all parts of this specification)

The Contractor shall furnish a detailed description of the tests, test procedures and results.

EW-9.5.3 Additional Testing

NPC reserves the right to specify further tests to be performed in order to be satisfied with the performance of the protective relaying system. Changes or additions in the testing procedures shall be mutually agreed upon by the Contractor and NPC.

Contractor's proposal shall indicate all costs and number of days for the performance of actual model power system testing. The Contractor shall provide cost per day for NPC's reference in case additional tests required by the NPC extend the testing time beyond what is actually required.

EW-9.6 DATA AND DOCUMENTATION REQUIREMENTS

EW-9.6.1 General

Contractor-furnished data and information shall be the guaranteed performance data, predicted performance, interface requirements and construction features of all Contractor's furnished equipment. The accuracy of such information and its compatibility with overall performance requirements specified by NPC are the sole responsibility of the Contractor.

All information submitted as part of Proposal Data will become part of contract data for successful bidder.

EW-9.6.2 Data and Information to be Submitted with the Proposal

Contractor shall furnish with his proposal the filled-in Section A.2.0 of the Technical Data Sheets.

EW-9.6.3 Data and Information to be Submitted During Post Qualification

Contractor shall furnish during post qualification the following:

a. Filled-in Section B.9.0 of the Technical Data Sheets.

b. Contractor shall furnish the brochures and catalogues during post qualification to support the filled-in Technical Data Sheets and to allow NPC to evaluate the equipment/materials being offered

EW-9.6.4 Data and Information to be Submitted After Award of Contract

The following items shall be submitted by the Contractor after award of contract:

a. Outline drawings of the protective relay and accessories showing all critical dimensions and weights, including the following:

   1. Mounting dimensions and details and transport dimensions;
   2. Plans, elevation and sectional views;
   3. Details of relay cubicle and its contents;
   4. Control and power cable entrance openings at the relay cubicle;
   5. Details of terminals and grounding connections;
   6. Channel and support column outline drawing

b. Schematic diagrams for control and protection including interlocking scheme;

c. Arrangement of terminal blocks inside the panel;

d. Bill of material and parts list of relay cubicle components;

e. Protective relay instruction manual covering installation, operation and maintenance;

f. Certified test data, if specified in the Technical Data Sheets;

g. Detailed QA Program based on ISO 9001;

h. Type test reports summary sheets for the equipment types (or similar type) included in the Tender;

i. Routine Tests Reports;

j. ISO 9001 Certification of the proposed manufacturer;

k. Field Test to be performed and Field Test Reports duly signed by NPC representative(s); and

l. As- built drawings as finally approved.

The Contractor shall provide in the manner, number of copies and within the time set forth in the NPC order, instruction manuals in accordance with Section GW-2.9 of the General Works.

SECTION VII

BILL OF QUANTITIES

TOTAL APPROVED BUDGET FOR THE CONTRACT

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
1.0	SUB-TOTAL FOR ELECTRICAL WORKS					_____ _____(P_____)	(P_____)
2.0	SUB-TOTAL FOR CIVIL WORKS					_____ _____(P_____)	(P_____)
	TOTAL ABC					_____ _____(P_____)	(P_____)

_____
Name of Firm

_____
Name and Signature of Authorized Representative

_____
Designation

ELECTRICAL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
A.	**SUBSTATION EQUIPMENT, MATERIALS AND OTHER APPURTENANCES TO BE SUPPLY, INSTALL & TEST BY THE CONTRACTOR**						
1.0	10MVA, 69/13.8kV, 3-Ph, 60Hz Two-Winding Transformer complete with the required accessories, appurtenances, spare parts and tools in accordance with the drawings and technical specifications.	Supply, Install & Test	Refer to NPC TS & Drawing	set	1	_____ _____(P_____)	(P_____)
2.0	660mm², 69 kV Bus Conductor, Hard-drawn Aluminum (HAL) Conductor complete with required associated line materials/ hardwares in accordance with the drawings and technical specifications.	Supply, Install & Test	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
3.0	Temporary 69kV Receiving Structure complete with the required steel pole, cross-arms, braces, bus conductor, line materials/ hardware, line guards/covering and other accessories in accordance with the drawings and technical specifications.	Supply, Erection & Installation	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
4.0	Temporary 15kV Receiving Structure complete with required steel pole, termination kits/lugs, and other accessories in accordance with the drawings and technical specifications.	Supply, Erection & Installation	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
5.0	New Substation Protection, Monitoring and Metering System, complete with auxiliary relays, instrument transformers, test blocks, etc. in accordance with the drawings and technical specifications.	Supply, Install & Test	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)

_____ Name of Firm

_____ Name and Signature of Authorized Representative

_____ Designation

ELECTRICAL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
6.0	125 Vdc Battery Charger complete with all the necessary devices and accessories including spare parts/tools in accordance with the drawings and technical specifications.	Supply & Install & Test	Refer to NPC TS & Drawing	set	1	_____ _____(P_____)	(P_____)
7.0	125 Vdc Battery Bank, complete with the required battery racks including spare parts/tools and accessories in accordance with the drawings and technical specifications.	Supply, Install & Test	Refer to NPC TS & Drawing	set	1	_____ _____(P_____)	(P_____)
8.0	Grounding System including grounding conductors, ground rods, exothermic connection, riser connection, etc. in accordance with with the drawings and technical specifications.	Supply, Install & Test	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
9.0	Power, Control & Instrumentation Cables complete with the required tagging, lugs, conduits, etc. in accordance with the drawings and technical specifications.	Supply, Install & Test	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
B.	**EXISTING SUBSTATION EQUIPMENT/APPURTENANCES TO BE DISMANTLE, RELOCATE, REINSTALL & TEST BY THE CONTRACTOR**						
1.0	Existing 5MVA, 69/13.8/13.8kV, 3-Ph, 60Hz Three-Winding Transformer including all associated accessories, appurtenances in accordance with the drawings and technical specifications.	Dismantle, Relocate Reinstall & Test	Refer to NPC TS & Drawing	set	1	_____ _____(P_____)	(P_____)
2.0	Modification of existing 15kV XLPE Power Cable (temporarily connecting secondary winding of relocated 5 MVA power transformer to the 13.8kV outdoor switchgear) in accordance with the drawings and technical specifications.	Dismantle & Reterminate	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)

_____ Name of Firm

_____ Name and Signature of Authorized Representative

_____ Designation

ELECTRICAL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
C.	**EXISTING SUBSTATION MATERIALS TO BE HAUL/ TRANSPORT, INSTALL AND TEST BY THE CONTRACTOR FROM NPC SPUG-LOD MINUYAN COMPLEX (MINUYAN, SAN JOSE DEL MONTE, BULACAN) TO ROXAS SUBSTATION (SITIO UMALAD, BRGY. 4, ROXAS, PALAWAN)**						
1.0	1C x 185mm², 15 kV Cross-Linked Polyethylene (XLPE) Power Cable	Haul, Install & Test	Refer to NPC TS & Drawing	li. m	200	_____ _____(P_____)	(P_____)
2.0	Control and Instrumentation Cables						
	a.) 2c x 2.0 mm^2	Haul, Install & Test	Refer to NPC TS & Drawing	li. m.	568	_____ _____(P_____)	(P_____)
	b.) 4c x 2.5 mm^2	Haul, Install & Test	Refer to NPC TS & Drawing	li. m.	510	_____ _____(P_____)	(P_____)
	c.) 8c x 2.5 mm^2	Haul, Install & Test	Refer to NPC TS & Drawing	li. m.	898	_____ _____(P_____)	(P_____)
	d.) 2c x 6 mm^2	Haul, Install & Test	Refer to NPC TS & Drawing	li. m.	520	_____ _____(P_____)	(P_____)

Name of Firm

Name and Signature of Authorized Representative

Designation

ELECTRICAL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
D.	**SUBSTATION EQUIPMENT / APPURTENANCES TO BE DISMANTLE & HAUL BY THE CONTRACTOR**						
1.0	Dismantling of the relocated 5MVA, 69/13.8/13.8kV, 3-Ph, 60Hz Three-Winding Transformer including all associated accessories appurtenances in accordance with the drawings and technical specifications.	Dismantle & Haul	Refer to NPC TS & Drawing	set	1	_____ _____(P_____)	(P_____)
2.0	Modified existing 15kV XLPE Power Cable (temporarily connecting secondary winding of relocated 5 MVA power transformer to the 13.8kV outdoor switchgear) in accordance with the drawings and technical specifications.	Dismantle, Recoil & Stock	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
3.0	Existing 15kV XLPE Power Cable (connecting tertiary winding of 5 MVA power transformer to the 13.8kV outdoor switchgear) complete with associated take-off termination kits/lugs, etc. in accordance with the drawings and technical specifications.	Dismantle, Recoil & Stock	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
4.0	Existing 69kV Bare Aluminum Conductor (connecting the 5 MVA power transformer to the disconnect switch) in accordance withthe drawings and technical specifications.	Dismantle, Recoil & Stock	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)
5.0	Temporary 69kV Receiving Structure complete with the required steel pole, cross-arms, braces, bus conductor, line materials/ hardware, line guards/covering and other accessories in accordance with the drawings and technical specifications. specifications.	Dismantle & Stock	Refer to NPC TS & Drawing	lot	1	_____ _____(P_____)	(P_____)

_____
Name of Firm

_____
Name and Signature of Authorized Representative

_____
Designation

ELECTRICAL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
6.0	Temporary 15kV Receiving Structure complete with required steel pole, termination kits/lugs, grounding materials and other accessories in accordance with the drawings and technical specifications.	Dismantle & Stock	Refer to NPC TS & Drawing	1	lot	_____ _____(P_____)	(P_____)
7.0	Existing Substation Protection, Monitoring and Metering System, together with auxiliary relays, instrument transformers, test blocks, etc.	Dismantle, Crate and Stock	Refer to NPC TS & Drawing	1	lot	_____ _____(P_____)	(P_____)
8.0	Existing 125 Vdc Battery Charger complete with other accessories/appurtenances	Dismantle, Crate and Stock	Refer to NPC TS & Drawing	1	set	_____ _____(P_____)	(P_____)
9.0	Existing 125 Vdc Battery Bank, battery racks and other accessories/appurtenances	Dismantle, Crate and Stock	Refer to NPC TS & Drawing	1	set	_____ _____(P_____)	(P_____)
10.0	Existing Instrumentation and Control Cables	Dismantle, Recoil & Stock	Refer to NPC TS & Drawing	1	lot	_____ _____(P_____)	(P_____)
	TOTAL ELECTRICAL WORKS (EW)					_____ _____(P_____)	(P_____)

Name of Firm

Name and Signature of Authorized Representative

Designation

CIVIL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
A.	**EXTENSION OF EXISTING TRANSFORMER PAD**						
1.0	Structural Excavation	excavate, stockpile, & reuse	Refer to NPC TS & Drawing	cu.m.	4.5	_____ _____(P_____)	_____(P_____)
2.0	Sand and Gravel Bedding	furnish, place, spread & compact	Refer to NPC TS & Drawing	cu.m.	1.2	_____ _____(P_____)	_____(P_____)
3.0	Concrete 3000psi (20.7 MPa)	furnish, place & vibrate	Refer to NPC TS & Drawing	cu.m.	5.6	_____ _____(P_____)	_____(P_____)
4.0	Reinforcing Bars (Grade 275)	furnish, cut, bend, schedule & install	Refer to NPC TS & Drawing	kg	481	_____ _____(P_____)	_____(P_____)
5.0	Concrete Epoxy Grout	furnish & apply	Refer to NPC TS & Drawing	lit.	10	_____ _____(P_____)	_____(P_____)
B.	**ESTABLISHMENT OF TEMPORARY TRANSFORMER PAD**						
1.0	Grading Fill (250mm thick)	place, spread & compact	Refer to NPC TS & Drawing	cu.m.	5	_____ _____(P_____)	_____(P_____)
2.0	Sand and Gravel Bedding	furnish, place, spread & compact	Refer to NPC TS & Drawing	cu.m.	1	_____ _____(P_____)	_____(P_____)

_____ Name of Firm

_____ Name and Signature of Authorized Representative

_____ Designation

CIVIL WORKS

Item No.	Description of Work or Materials	Work to Be Done	Reference	Unit	Estimated Quantity	Unit Price in Pesos (Words and Figures)	Total Amount (In Figures)
3.0	Good Lumber (1" x 12")	furnish & install	Refer to NPC TS & Drawing	bd.ft	34	_____ _____(P_____)	_____(P_____)
	TOTAL CIVIL WORKS (EW)					_____ _____(P_____)	(P_____)

_____ Name of Firm

_____ Name and Signature of Authorized Representative

_____ Designation

SECTION VIII

BIDDING FORMS

SECTION VIII – BIDDING FORMS

TABLE OF CONTENTS

Standard Form No: NPCSF-INFR-01

Checklist of Technical & Financial Envelope Requirements for Bidders

A. THE 1ST ENVELOPE (TECHNICAL COMPONENT) SHALL CONTAIN THE FOLLOWING:

1. ELIGIBILITY DOCUMENTS

a. (CLASS A)

➢ Any of the following:

- PhilGEPS Certificate of Registration and Membership under Platinum Category in accordance with Section 8.5.2 of the IRR;

OR:

- The following updated and valid Class "A" eligibility documents enumerated under "Annex A" of the Platinum Membership:
  - Registration Certificate from the Securities and Exchange Commission (SEC) for corporations, Department of Trade and Industry (DTI) for sole proprietorship, or Cooperative Development Authority (CDA) for cooperatives;
  - Mayor's/Business permit issued by the city or municipality where the principal place of business of the prospective bidder is located, or the equivalent document for Exclusive Economic Zones or Areas.

    In cases of recently expired Mayor's/Business permits, it shall be accepted together with the official receipt as proof that the bidder has applied for renewal within the period prescribed by the concerned local government unit, provided that the renewed permit shall be submitted as a post qualification requirement in accordance with Section 34.2 of the Revised IRR of RA 9184.
  - The prospective bidder's audited financial statements, showing, among others, the prospective bidder's total and current assets and liabilities, stamped "received" by the BIR or its duly accredited and authorized institutions, for the preceding calendar year which should not be earlier than two (2) years from the date of bid submission.
  - Tax clearance per Executive Order 398, Series of 2005, as finally reviewed and approved by the BIR;
  - Valid Philippine Contractors Accreditation Board (PCAB) license and registration for the type and cost of the contract for this Project or Special PCAB License in case of Joint Ventures.

OR:

- A combination thereof.

➢ Statement of all its ongoing government and private contracts if any, whether similar or not similar in nature and complexity to the contract to be bid *(NPCSF-INFR-02)*

➢ The Statement of the bidder's Single Largest Completed Contract (SLCC) similar to the contract to be bid, and whose value, adjusted to current prices using the Philippine Statistics Authority (PSA) consumer price index, must be at least 50% of the ABC *(NPCSF-INFR-03)* complete with the following supporting documents:

- Contract/Purchase Order
- Owner's Certificate of Final Acceptance issued by the project owner other than the contractor or a final rating of at least Satisfactory in the Constructors Performance Evaluation System (CPES). In case of contracts with the private sector, an equivalent document (Ex. Official Receipt or Sales Invoice) shall be submitted

(The Single Largest Completed Contract (SLCC) as declared by the bidder shall be verified and validated to ascertain such completed contract. Hence, bidders must ensure access to sites of such projects/equipment to NPC representatives for verification and validation purposes during post-qualification process.

It shall be a ground for disqualification, if verification and validation cannot be conducted due to inaccessibility of the site for whatever reason or fault of the bioder.)

- Special PCAB License in case of Joint Ventures
- Duly signed computation of its Net Financial Contracting Capacity (NFCC) at least equal to the ABC *(NPCSF-INFR-04)*;

b. (CLASS B)

- Valid Joint Venture Agreement, if applicable *(NPCSF-INFR-05)*

2. Technical Documents

- Bid Security, any one of the following:
  - Bid Securing Declaration (*NPCSF-INFR-06c*)

    OR
  - Cash or Cashier's/Manager's check issued by a Universal or Commercial Bank – 2% of ABC;

    OR
  - Bank draft/guarantee or irrevocable letter of credit issued by a Universal or Commercial Bank: *(NPCSF-INFR-06a) - 2% of ABC;*

    OR
  - Surety Bond callable upon demand issued by a reputable surety or insurance company *(NPCSF-INFR-06b) - 5% of ABC, with*
    - Certification from the Insurance Commission as authorized company to issue surety
- Duly signed, completely filled-out and notarized Omnibus Sworn statement (Revised) (NPCSF-INFR-07), complete with the following attachments:
  - For Sole Proprietorship:
    - Special Power of Attorney
  - For Partnership/Corporation/Cooperative/Joint Venture:
    - Document showing proof of authorization (e.g., duly notarized Secretary's Certificate, Board/Partnership Resolution, or Special Power of Attorney, whichever is applicable)
- Organization Chart for the project *(NPCSF-INFR-08)*
- Duly Signed List of Contractor's Key Personnel (based on the minimum key personnel) with complete supporting documents *(NPCSF-INFR-09,10a,10b & 11)*
- Duly Signed List of Contractor's Equipment (owned, leased or under purchase agreement *(NPCSF-INFR-12), with*
  - Proof of ownership and/or certificate of availability issued by Equipment Lessors

- Documents to be submitted with the Bid Proposal as specified in Annex A of Section VI – Part II, Technical Data Sheet (Electrical Works)
- Complete eligibility documents of proposed sub-contractor, if applicable

B. THE 2ND ENVELOPE (FINANCIAL COMPONENT) SHALL CONTAIN THE FOLLOWING:

- Duly signed Bid Letter indicating the total bid amount in accordance with the prescribed form (*NPCSF-INFR-13)*
- Duly signed and completely filled-out Bill of Quantities *(Section VII)* indicating the unit and total prices per item and the total amount in the prescribed Bill of Quantities form.
- Duly Signed Detailed Estimates for each items of work showing the computations in arriving at each item's unit prices used in coming up with the bid (*NPCSF-INFR-14)*
- Summary sheets indicating the direct unit prices of construction materials, labor rates and equipment rental rates used in coming up with the bid (*NPCSF-INFR-15)*

CONDITIONS:

1. *Each Bidder shall submit one copy of the first and second components of its Bid. NPC may request additional hard copies and/or electronic copies of the Bid. However, failure of the Bidders to comply with the said request shall not be a ground for disqualification.*
2. *A Bidder not submitting bid for reason that his cost estimate is higher than the ABC, is required to submit his letter of non-participation/regret supported by corresponding detailed estimates. Failure to submit the two (2) documents shall be understood as acts that tend to defeat the purpose of public bidding without valid reason as stated under Section 69.1.(i) of the revised IRR of R.A. 9184.*

Standard Form Number: NPCSF-INFR-02

List of All Ongoing Government and Private Contracts Including Contract Awarded But Not Yet Started

Business Name : _____

Business Address : _____

Name of Contract/Location/ Project Cost	a. Owner's Name b. Address c. Telephone Nos.	Nature of Work	Contractor's Role		a. Date Awarded b. Date Started c. Date of Completion or Estimated Completion Time	Value of Outstanding Works
			Description	%		
Government						
Private						
					Total Cost	

The bidder shall declare in this form all his on-going government and private contracts including contracts where the bidder (either as individual or as a Joint Venture) is a partner in a Joint Venture agreement other than his current joint venture where he is a partner. Non declaration will be a ground for disqualification of bid.

Note : This statement shall be supported with the following documents for all the contract(s) stated above which shall be submitted during Post-qualification:

1. Contract/Purchase Order and/or Notice of Award
2. Certification coming from the project owner/client that the performance is satisfactory as of the bidding date.

Submitted by : _____
(Printed Name & Signature)

Designation : _____

Date : _____

Standard Form Number: NPCSF-INFR-03

The Statement of the bidder's Single Largest Completed Contract (SLCC) similar to the contract to be bid

Business Name : _____
Business Address : _____

Name of Contract	a. Owner's Name b. Address c. Telephone Nos.	Nature of Work	Contractor's Role		a. Amount at Award b. Amount at Completion c. Duration	a. Date Awarded b. Contract Effectivity c. Date Completed
			Description	%		

Notes:
1. The bidder must state only one (1) Single Largest Completed Contract (SLCC) similar to the contract to be bid.
2. Supporting documents such as Contract/Purchase Order and any of the following: Owner's Certificate of Final Acceptance issued by the project owner other than the contractor; *or* A final rating of at least Satisfactory in the Constructors Performance Evaluation System (CPES); *or* Official Receipt (O.R); *or* Sales Invoice for the contract stated above shall be submitted during Bid Opening.

Submitted by _____
(Printed Name & Signature)

Designation : _____
Date : _____

Standard Form Number: NPCSF-INFR-04

NET FINANCIAL CONTRACTING CAPACITY (NFCC)

A. Summary of the Bidder's/Contractor's assets and liabilities on the basis of the income tax return and audited financial statement for the immediately preceding calendar year are:

		Year 20__
1.	Total Assets	
2.	Current Assets	
3.	Total Liabilities	
4.	Current Liabilities	
5.	Net Worth (1-3)	
6.	Net Working Capital (2-4)	

B. The Net Financial Contracting Capacity (NFCC) based on the above data is computed as follows:

NFCC = [(Current assets minus current liabilities) x 15] minus the value of all outstanding or uncompleted portions of the projects under ongoing contracts, including awarded contracts yet to be started coinciding with the contract for this Project.

NFCC = P _____

Herewith attached is certified true copy of the audited financial statement, stamped "RECEIVED" by the BIR or BIR authorized collecting agent for the immediately preceding calendar year.

Submitted by:

_____
Name of Bidder/Contractor

_____
Signature of Authorized Representative

Date : _____

Standard Form Number: NPCSF-INFR-05

JOINT VENTURE AGREEMENT

KNOW ALL MEN BY THESE PRESENTS:

That this JOINT VENTURE AGREEMENT is entered into by and between: _____, of legal age, *(civil status)* _____, authorized representative of _____ and a resident of _____.

- and –

_____, of legal age, *(civil status)* _____, authorized representative of _____ a resident of _____.

That both parties agree to join together their capital, manpower, equipment, and other resources and efforts to enable the Joint Venture to participate in the Bidding and Undertaking of the hereunder stated Contract of the **National Power Corporation.**

NAME OF PROJECT	**CONTRACT AMOUNT**
_____	_____

That the capital contribution of each member firm:

NAME OF FIRM	CAPITAL CONTRIBUTION
1.	₱
2.	₱

That both parties agree to be jointly and severally liable for their participation in the Bidding and Undertaking of the said contract.

That both parties agree that _____ and/or _____ shall be the Official Representative/s of the Joint Venture, and are granted full power and authority to do, execute and perform any and all acts necessary and/or to represent the Joint Venture in the Bidding and Undertaking of the said contract, as fully and effectively and the Joint Venture may do and if personally present with full power of substitution and revocation.

That this Joint Venture Agreement shall remain in effect only for the above stated Contract until terminated by both parties.

_____
Name & Signature of Authorized Representative

_____
Official Designation

_____
Name of Firm

_____
Name & Signature of Authorized Representative

_____
Official Designation

_____
Name of Firm

Witnesses

1. _____ 2. _____

[Jurat]

[Format shall be based on the latest Rules on Notarial Practice]

If the bidder is a joint venture, one of the requirements is the submission of a valid joint venture agreement.

Standard Form Number: NPCSF-INFR-06a

FORM OF BID SECURITY (BANK GUARANTEE)

WHEREAS, *(Name of Bidder)* _____ (hereinafter called "the Bidder") has submitted his bid dated *(Date)* _____ for the *[name of project]* (hereinafter called "the Bid").

KNOW ALL MEN by these presents that We *(Name of Bank)* _____ of *(Name of Country)* _____ having our registered office at _____ (hereinafter called "the Bank" are bound unto National Power Corporation (hereinafter called "the Entity") in the sum of *[amount in words & figures as prescribed in the bidding documents]* for which payment well and truly to be made to the said Entity the Bank binds himself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this _____ day of _____ 20___.

THE CONDITIONS of this obligation are that:

1) if the Bidder withdraws his Bid during the period of bid validity specified in the Bidding Documents; or

2) if the Bidder does not accept the correction of arithmetical errors of his bid price in accordance with the Instructions to Bidder; or

3) if the Bidder, having determined as the LCB, fails or refuses to submit the required tax clearance, latest income and business tax returns and PhilGEPs registration certificate within the prescribed period; or

4) if the Bidder having been notified of the acceptance of his bid and award of contract to him by the Entity during the period of bid validity:

   a) fails or refuses to execute the Contract; or

   b) fails or refuses to submit the required valid JVA, if applicable; or

   c) fails or refuses to furnish the Performance Security in accordance with the Instructions to Bidders;

we undertake to pay to the Entity up to the above amount upon receipt of his first written demand, without the Entity having to substantiate its demand, provided that in his demand the Entity will note that the amount claimed by it is due to the occurrence of any one or combination of the four (4) conditions stated above.

The Guarantee will remain in force up to 120 days after the opening of bids or as it may be extended by the Entity, notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

DATE _____ SIGNATURE OF THE BANK _____

WITNESS _____ SEAL _____

_____

(Signature, Name and Address)

Standard Form Number: NPCSF-INFR-06b

FORM OF BID SECURITY (SURETY BOND)

BOND NO.: _____ DATE BOND EXECUTED: _____

By this bond, We (*Name of Bidder*) _____ (hereinafter called "the Principal") and (*Name of Surety*) _____ of (*Name of Country of Surely*) _____, authorized to transact business in the Philippines (hereinafter called "the Surety") are held and firmly bound unto National Power Corporation (hereinafter called "the Employer") as Obligee, in the sum of (*amount in words & figures as prescribed in the bidding documents*), callable on demand, for the payment of which sum, well and truly to be made, we, the said Principal and Surety bind ourselves, our successors and assigns, jointly and severally, firmly by these presents.

SEALED with our seals and dated this _____ day of _____ 20 _____

WHEREAS, the Principal has submitted a written Bid to the Employer dated the _____ day of _____ 20 _____, for the _____ _____ (hereinafter called "the Bid").

NOW, THEREFORE, the conditions of this obligation are:

1) if the Bidder withdraws his Bid during the period of bid validity specified in the Bidding Documents; or

2) if the Bidder does not accept the correction of arithmetical errors of his bid price in accordance with the Instructions to Bidder; or

3) if the Bidder, having determined as the LCB, fails or refuses to submit the required tax clearance, latest income and business tax returns and PhilGEPs registration certificate within the prescribed period; or

4) if the Bidder having been notified of the acceptance of his bid and award of contract to him by the Entity during the period of bid validity:

   d) fails or refuses to execute the Contract; or

   e) fails or refuses to submit the required valid JVA, if applicable; or

   f) fails or refuses to furnish the Performance Security in accordance with the Instructions to Bidders;

then this obligation shall remain in full force and effect, otherwise it shall be null and void.

PROVIDED HOWEVER, that the Surety shall not be:

a) liable for a greater sum than the specified penalty of this bond, nor

b) liable for a greater sum that the difference between the amount of the said Principal's Bid and the amount of the Bid that is accepted by the Employer.

Standard Form Number: NPCSF-INFR-06b
Page 2 of 2

This Surety executing this instrument hereby agrees that its obligation shall be valid for 120 calendar days after the deadline for submission of Bids as such deadline is stated in the Instructions to Bidders or as it may be extended by the Employer, notice of which extension(s) to the Surety is hereby waived.

PRINCIPAL _____ SURETY _____

SIGNATURE(S) _____ SIGNATURES(S) _____

NAME(S) AND TITLE(S) _____ NAME(S) _____

SEAL _____ SEAL _____

Standard Form No: NPCSF-INFR-06c

REPUBLIC OF THE PHILIPPINES)
CITY OF _____) S.S.

BID-SECURING DECLARATION
UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION
LuzP22Z1447Se

To: **National Power Corporation**
BIR Road cor. Quezon Ave.
Diliman, Quezon City

I/We[1], the undersigned, declare that:

1. *I/We* understand that, according to your conditions, bids must be supported by a Bid Security, which may be in the form of a Bid-Securing Declaration.
2. *I/We* accept that: (a) *I/we* will be automatically disqualified from bidding for any contract with any procuring entity for a period of two (2) years upon receipt of your Blacklisting Order; and, (b) *I/we* will pay the applicable fine provided under Section 6 of the Guidelines on the Use of Bid Securing Declaration, within fifteen (15) days from receipt of the written demand by the Procuring Entity for the commission of acts resulting to the enforcement of the Bid Securing Declaration under Sections 23.1 (b), 34.2, 40.1 and 69.1, except 69.1 (f) of the IRR of R.A. 9184; without prejudice to other legal action the government may undertake.
3. *I/We* understand that this Bid-Securing Declaration shall cease to be valid on the following circumstances:
   (a) Upon expiration of the bid validity period, or any extension thereof pursuant to your request;
   (b) *I am/we are* declared ineligible or post-disqualified upon receipt of your notice to such effect, and (i) *I/we* failed to timely file a request for reconsideration or (ii) *I/we* filed a waiver to avail of said right;
   (c) *I am/we are* declared as the bidder with the Lowest Calculated and Responsive Bid, and *I/we* have furnished the performance security and signed the Contract.

IN WITNESS WHEREOF, *I/we* have hereunto set my hand this ____ day of ____ 20____ at _____, Philippines.

_____
[Name and Signature of Bidder's Representative/ Authorized Signatory] [Signatory's legal capacity]
Affiant

[Jurat]
[Format shall be based on the latest Rules on Notarial Practice]

[1] *Select one and delete the other. Adopt same instruction for similar terms throughout the document.*

Standard Form No: NPCSF-INFR-07

Omnibus Sworn Statement (Revised)

REPUBLIC OF THE PHILIPPINES)
CITY/MUNICIPALITY OF _____) S.S.

AFFIDAVIT

I, [Name of Affiant], of legal age, [Civil Status], [Nationality], and residing at [Address of Affiant], after having been duly sworn in accordance with law, do hereby depose and state that:

1. *[Select one, delete the other:]*

   [If a sole proprietorship:] I am the sole proprietor or authorized representative of [Name of Bidder] with office address at [address of Bidder];

   [If a partnership, corporation, cooperative, or joint venture:] I am the duly authorized and designated representative of [Name of Bidder] with office address at [address of Bidder];

2. *[Select one, delete the other:]*

   [If a sole proprietorship:] As the owner and sole proprietor, or authorized representative of [Name of Bidder], I have full power and authority to do, execute and perform any and all acts necessary to participate, submit the bid, and to sign and execute the ensuing contract for [Name of the Project] of the [Name of the Procuring Entity], as shown in the attached duly notarized Special Power of Attorney;

   [If a partnership, corporation, cooperative, or joint venture:] I am granted full power and authority to do, execute and perform any and all acts necessary to participate, submit the bid, and to sign and execute the ensuing contract for [Name of the Project] of the [Name of the Procuring Entity], as shown in the attached [state title of attached document showing proof of authorization (e.g., duly notarized Secretary's Certificate, Board/Partnership Resolution, or Special Power of Attorney, whichever is applicable;)];

3. [Name of Bidder] is not "blacklisted" or barred from bidding by the Government of the Philippines or any of its agencies, offices, corporations, or Local Government Units, foreign government/foreign or international financing institution whose blacklisting rules have been recognized by the Government Procurement Policy Board, by itself or by relation, membership, association, affiliation, or controlling interest with another blacklisted person or entity as defined and provided for in the Uniform Guidelines on Blacklisting;

4. Each of the documents submitted in satisfaction of the bidding requirements is an authentic copy of the original, complete, and all statements and information provided therein are true and correct;

5. [Name of Bidder] is authorizing the Head of the Procuring Entity or its duly authorized representative(s) to verify all the documents submitted;

6. *[Select one, delete the rest:]*

   [If a sole proprietorship:] The owner or sole proprietor is not related to the Head of the Procuring Entity, members of the Bids and Awards Committee (BAC), the Technical Working Group, and the BAC Secretariat, the head of the Project Management Office or the end-user unit, and the project consultants by consanguinity or affinity up to the third civil degree;

   [If a partnership or cooperative:] None of the officers and members of *[Name of Bidder]* is related to the Head of the Procuring Entity, members of the Bids and Awards Committee

(BAC), the Technical Working Group, and the BAC Secretariat, the head of the Project Management Office or the end-user unit, and the project consultants by consanguinity or affinity up to the third civil degree;

[If a corporation or joint venture:] None of the officers, directors, and controlling stockholders of *[Name of Bidder]* is related to the Head of the Procuring Entity, members of the Bids and Awards Committee (BAC), the Technical Working Group, and the BAC Secretariat, the head of the Project Management Office or the end-user unit, and the project consultants by consanguinity or affinity up to the third civil degree;

7. *[Name of Bidder]* complies with existing labor laws and standards; and

8. *[Name of Bidder]* is aware of and has undertaken the responsibilities as a Bidder in compliance with the Philippine Bidding Documents, which includes:

   a. Carefully examining all of the Bidding Documents;

   b. Acknowledging all conditions, local or otherwise, affecting the implementation of the Contract;

   c. Making an estimate of the facilities available and needed for the contract to be bid, if any; and

   d. Inquiring or securing Supplemental/Bid Bulletin(s) issued for the *[Name of the Project]*.

9. *[Name of Bidder]* did not give or pay directly or indirectly, any commission, amount, fee, or any form of consideration, pecuniary or otherwise, to any person or official, personnel or representative of the government in relation to any procurement project or activity.

10. In case advance payment was made or given, failure to perform or deliver any of the obligations and undertakings in the contract shall be sufficient grounds to constitute criminal liability for Swindling (Estafa) or the commission of fraud with unfaithfulness or abuse of confidence through misappropriating or converting any payment received by a person or entity under an obligation involving the duty to deliver certain goods or services, to the prejudice of the public and the government of the Philippines pursuant to Article 315 of Act No. 3815 s. 1930, as amended, or the Revised Penal Code.

IN WITNESS WHEREOF, I have hereunto set my hand this __ day of ___, 20__ at _____, Philippines.

[Insert NAME OF BIDDER OR ITS AUTHORIZED REPRESENTATIVE]
[Insert signatory's legal capacity]
Affiant

[Jurat]
[Format shall be based on the latest Rules on Notarial Practice]

Standard Form Number: NPCSF-INFR-08

CONTRACTOR'S ORGANIZATIONAL CHART FOR THE CONTRACT

Submit Copy of the Organizational Chart that the Contractor intends to use to execute the Contract if awarded to him. Indicate in the chart the names of the Project Manager, Project Engineer, Foreman and other Key Engineering Personnel.

Attach the required Proposed Organizational Chart for the Contract as stated above

NOTES:

1. *This organization chart should represent the "Contractor's Organization" required for the Project, and not the organizational chart of the entire firm.*
2. *Each such nominated engineer/key personnel shall comply with and submit duly accomplished forms NPCSF-INFR-10a, NPCSF-INFR-10b and NPCSF-INFR-11.*
3. *All these are required to be in the Technical Envelope of the Bidder.*

Standard Form Number: NPCSF-INFR-09

LIST OF KEY PERSONNEL PROPOSED TO BE ASSIGNED TO THE CONTRACT

(Based on the Minimum Key Personnel Required in the Bidding Documents)

Business Name: _____

Business: _____

_____

		DESIGNATION				
1	Name					
2	Address					
3	Date of Birth					
4	Employed Since					
5	Experience					
6	Previous Employment					
7	Education					
8	PRC License					

Required Attachments:

1. *Certificate of Employment, Bio Data and Construction Safety and Health Training Certificate of the Safety Officer*
2. *Certificate of Employment, Bio Data and valid PRC License of the (professional) personnel*

Submitted by: _____

(Printed Name & Signature)

Designation: _____

Date: _____

One of the requirements from the bidder to be included in its Technical Envelope is a list of contractor's key personnel (based on the minimum key personnel required in the bidding documents) to be assigned to the contract to be bid, with their complete qualification and experience data (including the key personnel's signed written commitment to work for the project once awarded the contract).

Standard Form Number: NPCSF-INFR-10a

KEY PERSONNEL'S CERTIFICATE OF EMPLOYMENT
(PROFESSIONAL PERSONNEL)

_____
Issuance Date

THE PRESIDENT
National Power Corporation
BIR Road cor. Quezon Ave.
Diliman, Quezon City

Dear Sir:

I am *(Name of Nominee)* _____ a Licensed _____ Engineer with Professional License No. _____ issued on *(date of issuance)* _____ at *(place of issuance)* _____.

I hereby certify that *(Name of Bidder)* _____ has engaged my services as *(Designation)* _____ for the *(Name of Project)* _____, if awarded to it.

As *(Designation)* _____, I supervised the following completed projects similar to the contract under bidding:

NAME OF PROJECT	OWNER	COST	DATE COMPLETED

At present, I am supervising the following projects:

NAME OF PROJECT	OWNER	COST	DATE COMPLETED

In case of my separation for any reason whatsoever from the above-mentioned Contractor, I shall notify the National Power Corporation at least twenty one (21) days before the effective date of my separation.

As *(Designation)* _____, I know I will have to stay in the job site all the time to supervise and manage the Contract works to the best of my ability, and aware that I am authorized to handle only one (1) contract at a time.

I do not allow the use of my name for the purpose of enabling the above-mentioned Contractor to qualify for the Contract without any firm commitment on my part to assume the post of *(Designation)* _____ therefor, if the contract is awarded to him since I understand that to do so will be a sufficient ground for my disqualification as *(Designation)* _____ in any future National Power Corporation bidding or employment with any Contractor doing business with the National Power Corporation.

_____
(Name and Signature)
AFFIANT

[Jurat]

[Format shall be based on the latest Rules on Notarial Practice]

One of the requirements from the bidder to be included in its Technical Envelope is a list of contractor's key personnel (viz. Project Manager, Project Engineer, Construction Safety Officer, Foremen, etc), to be assigned to the contract to be bid, with their complete qualification and experience data (including the key personnel's signed written commitment to work for the project once awarded the contract).

Standard Form Number: NPCSF-INFR-10b

KEY PERSONNEL'S CERTIFICATE OF EMPLOYMENT
(CONSTRUCTION SAFETY AND HEALTH OFFICER)

_____
Issuance Date

THE PRESIDENT
National Power Corporation
BIR Road cor. Quezon Ave.
Diliman, Quezon City

Dear Sir:

I am *(Name of Nominee)* _____ an Construction Safety & Health Officer with Certificate No. _____ issued on *(date of issuance)* _____ at *(place of issuance)* _____.

I hereby certify that *(Name of Bidder)* _____ has engaged my services as Construction Safety & Health Officer for the *(Name of Project)* _____, if awarded to it.

I am the Construction Safety & Health Officer of the following completed projects similar to the contract under bidding:

NAME OF PROJECT	OWNER	COST	DATE COMPLETED

At present, I am the Construction Safety & Health Officer of the following projects:

NAME OF PROJECT	OWNER	COST	DATE COMPLETED

In case of my separation for any reason whatsoever from the above-mentioned Contractor, I shall notify the National Power Corporation at least twenty one (21) days before the effective date of my separation.

As Construction Safety & Health Officer, I know I will have to stay in the job site all the time and aware that I am authorized to handle only one (1) contract at a time.

I do not allow the use of my name for the purpose of enabling the above-mentioned Contractor to qualify for the Contract without any firm commitment on my part to assume the post of Construction Safety & Health Officer, if the contract is awarded to him since I understand that to do so will be a sufficient ground for my disqualification as Construction Safety & Health Officer in any future National Power Corporation bidding or employment with any Contractor doing business with the National Power Corporation.

_____
(Name and Signature)
AFFIANT

[Jurat]
[Format shall be based on the latest Rules on Notarial Practice]

One of the requirements from the bidder to be included in its Technical Envelope is a list of contractor's key personnel (viz. Project Manager, Project Engineer, Construction Safety Officer, Foremen, etc), to be assigned to the contract to be bid, with their complete qualification and experience data (including the key personnel's signed written commitment to work for the project once awarded the contract).

Standard Form Number: NPCSF-INFR-11

KEY PERSONNEL
(FORMAT OF BIO-DATA)

Give the detailed information of the following personnel who are scheduled to be assigned as full-time field staff for the project. Fill up a form for each person.

1. Name : _____
2. Date of Birth : _____
3. Nationality : _____
4. Education and Degrees : _____
5. Specialty : _____
6. Registration : _____
7. Length of Service with the Firm : _____ Year from _____ (months) _____ (year)
   To _____ (months) _____ (year)
8. Years of Experience : _____
9. If Item 7 is less than ten (10) years, give name and length of service with previous employers for a ten (10)-year period (attached additional sheet/s), if necessary:

Name and Address of Employer	Length of Service
_____	_____ year(s) from _____ to _____
_____	_____ year(s) from _____ to _____
_____	_____ year(s) from _____ to _____

10. Experience:

    This should cover the past ten (10) years of experience. (Attached as many pages as necessary to show involvement of personnel in projects using the format below).

One of the requirements from the bidder to be included in its Technical Envelope is a list of contractor's key personnel (viz. Project Manager, Project Engineer, Construction Safety Officer, Foremen, etc), to be assigned to the contract to be bid, with their complete qualification and experience data (including the key personnel's signed written commitment to work for the project once awarded the contract).

Standard Form Number: NPCSF-INFR-11
Page 2 of 2

1. Name : _____

2. Name and Address of Owner : _____

3. Name and Address of the Owner's Engineer (Consultant) : _____

4. Indicate the Features of Project (particulars of the project components and any other particular interest connected with the project): _____

5. Contract Amount Expressed in Philippine Currency : _____

6. Position : _____

7. Structures for which the employee was responsible : _____

8. Assignment Period : from _____ (months) _____ (years)
: to _____ (months) _____ (years)

_____
Name and Signature of Employee

It is hereby certified that the above personnel can be assigned to this project, if the contract is awarded to our company.

_____ _____
(Place and Date) (The Authorized Representative)

One of the requirements from the bidder to be included in its Technical Envelope is a list of contractor's key personnel (viz. Project Manager, Project Engineer, Construction Safety Officer, Foremen, etc), to be assigned to the contract to be bid, with their complete qualification and experience data (including the key personnel's signed written commitment to work for the project once awarded the contract).

Standard Form Number: NPCSF-INFR-12

LIST OF EQUIPMENT, OWNED OR LEASED AND/OR UNDER PURCHASE AGREEMENTS

(Based on the Minimum Equipment Required in the Bidding Documents)

Business Name: _____

Business: _____

_____

Description	Model/Year	Capacity / Performance / Size	Plate No.	Motor No. / Body No.	Location	Condition	Proof of Ownership / Lessor or Vendor
A. Owned							
i.							
ii.							
iii.							
iv.							
v.							
B. Leased							
i.							
ii.							
iii.							
iv.							
v.							
C. Under Purchase Agreements							
i.							
ii.							
iii.							
iv.							
v.							

Submitted by: _____

(Printed Name & Signature)

Designation: _____

Date: _____

One of the requirements from the bidder to be included in its Technical Envelope is the list of its equipment units pledged for the contract to be bid, based on minimum equipment required in the bidding docs. which are owned (supported by proof/s of ownership), leased, and/or under purchase agreements (with corresponding engine numbers, chassis numbers and/or serial numbers), supported by certification of availability of equipment from the equipment lessor/vendor for the duration of the project

Standard Form No. : NPCSF-INFR-13

BID LETTER

Date: _____

To: **THE PRESIDENT**
National Power Corporation
BIR Road cor. Quezon Ave.
Diliman, Quezon City

We, the undersigned, declare that:

(a) We have examined and have no reservation to the Bidding Documents, including Addenda, for the Contract **UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION (LuzP22Z1447Se).**

(b) We offer to execute the Works for this Contract in accordance with the Bid Documents, Technical Specifications, General and Special Conditions of Contract accompanying this Bid;

The total price of our Bid, excluding any discounts offered below is: *[insert information]* _____;

The discounts offered and the methodology for their application are: *[insert information]* _____;

(c) Our Bid shall be valid for a period of *[insert number]* _____ days from the date fixed for the Bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(d) If our Bid is accepted, we commit to obtain a Performance Security in the amount of *[insert percentage amount]* _____ percent of the Contract Price for the due performance of the Contract;

(e) Our firm, including any subcontractors or suppliers for any part of the Contract, have nationalities from the following eligible countries: *[insert information]* _____;

(f) We are not participating, as Bidders, in more than one Bid in this bidding process, other than alternative offers in accordance with the Bidding Documents;

(g) Our firm, its affiliates or subsidiaries, including any subcontractors or suppliers for any part of the Contract, has not been declared ineligible by the Funding Source;

(h) We understand that this Bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding contract between us, until a formal Contract is prepared and executed; and

(i) We understand that you are not bound to accept the Lowest Calculated Bid or any other Bid that you may receive.

(j) We likewise certify/confirm that the undersigned, is the duly authorized representative of the bidder, and granted full power and authority to do, execute and perform any and all acts necessary to participate, submit the bid, and to sign and execute the ensuing contract for the **UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION (LuzP22Z1447Se)** of the National Power Corporation.

(k) We acknowledge that failure to sign each and every page of this Bid Letter, including the Bill of Quantities, shall be a ground for the rejection of our bid.

Name: _____

In the capacity of: _____

Signed: _____

Duly authorized to sign the Bid for and on behalf of: _____

Date: _____

Standard Form No. : NPCSF-INFR-14

DETAILED COST ESTIMATE FORM

Name of Bidder : _____

Item No.	Item Description	Unit of Measure	Direct Cost			Mark-Up		VAT	Unit Cost	Total Price
			Materials	Labor	Equipment	OCM	Profit			

_____ Name, Signature of Authorized Representative

_____ Designation

Standard Form No. : NPCSF-INFR-15

SUMMARY SHEETS OF MATERIALS PRICES, LABOR RATES AND EQUIPMENT RENTAL RATES

Name of Bidder : _____

I. Unit Prices of Materials

Materials Description	Unit	Unit Price
1.		
2.		
3.		
4.		
5.		
6.		
7.		

II. Manpower Hourly Rates

Designation	Rate/Hr.
1.	
2.	
3.	
4.	
5.	
6.	
7.	

III. Equipment Hourly Rental Rates

Equipment Description	Rental Rate/Hr.
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Name, Signature of Authorized Representative

Designation

SECTION IX

BID DRAWINGS

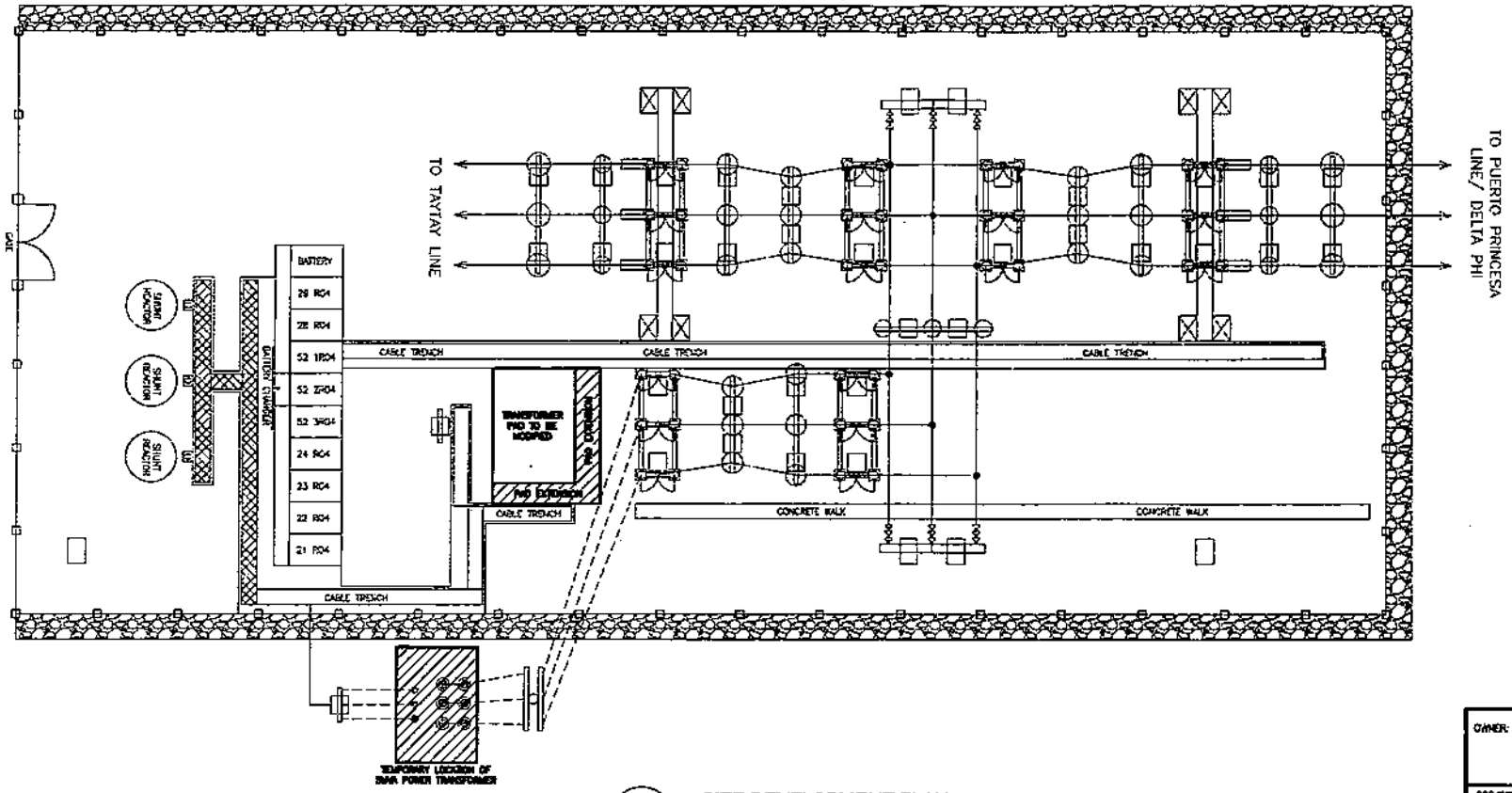
BID DRAWINGS

CIVIL WORKS

TABLE OF CONTENTS

LEGEND:

▨ – FOR CONSTRUCTION



SITE DEVELOPMENT PLAN

SCALE 1:200

OWNER: NATIONAL POWER CORPORATION
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: SITE DEVELOPMENT PLAN (ROXAS SUBSTATION)

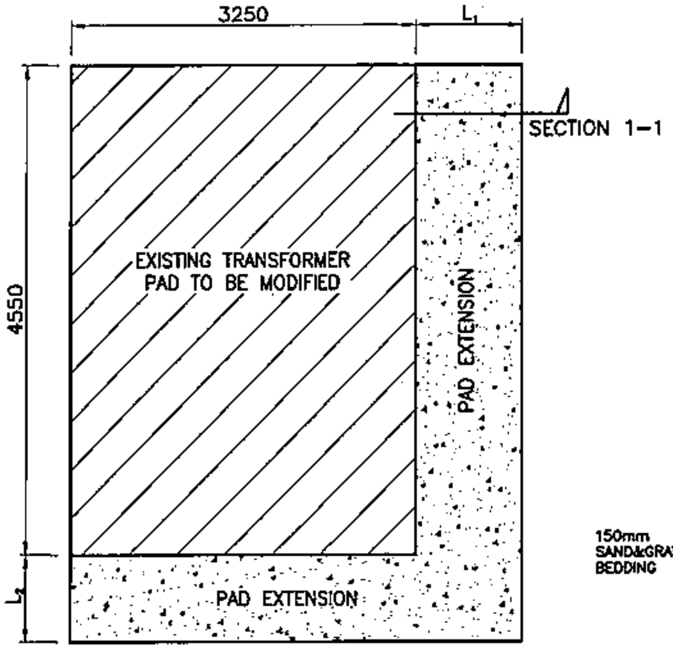
	BY	CHKD	DATE
DESIGNED			
DRAWN			
REVIEWED	PRINCIPAL ENGR. / ARCHT.		
CIVIL/ARCHT			
ELEC.			
MECH.			

SUBMITTED: H. L. MENDOZA
RECOMMENDED: A. C. [illegible]
APPROVED: N. G. [illegible]

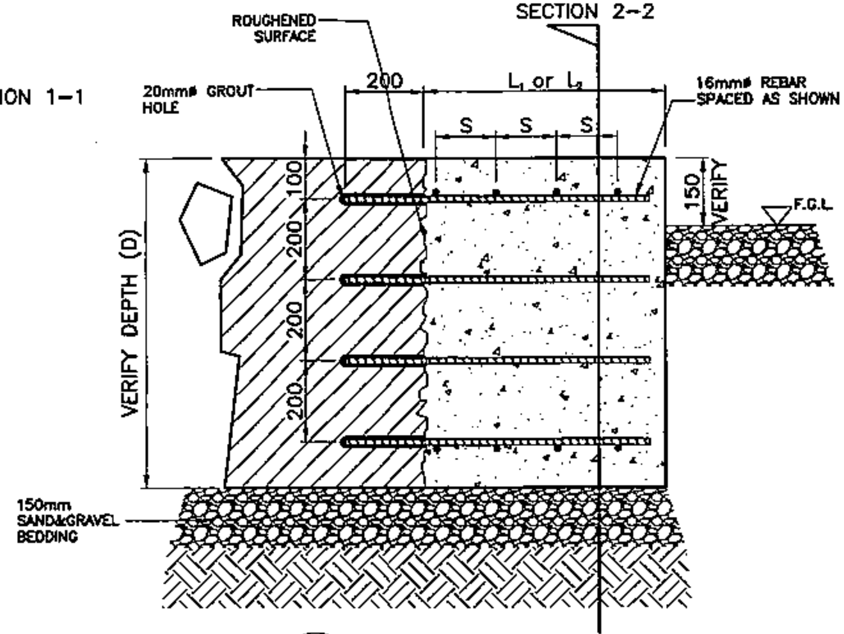
DWG. NO. ROSS-BDC-22.001 SPECS. NO. LuzP22Z1447Se

SCALE: AS SHOWN BID DRAWING REV. 0

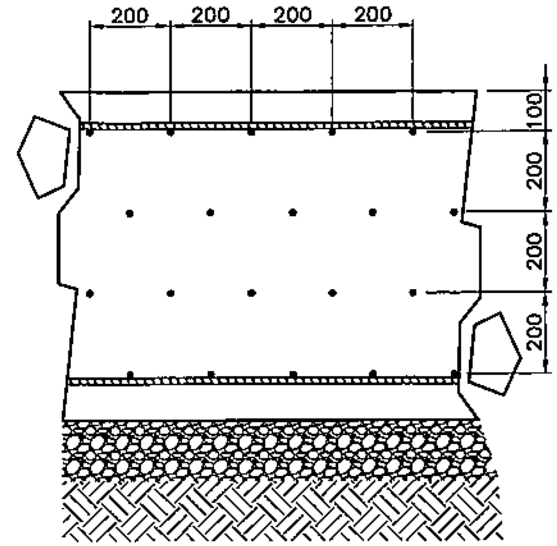
REV.	DATE	NATURE OF REVISION	BY	CHKD.	RECD.	APPD.



TRANSFORMER PAD PLAN
SCALE 1:50



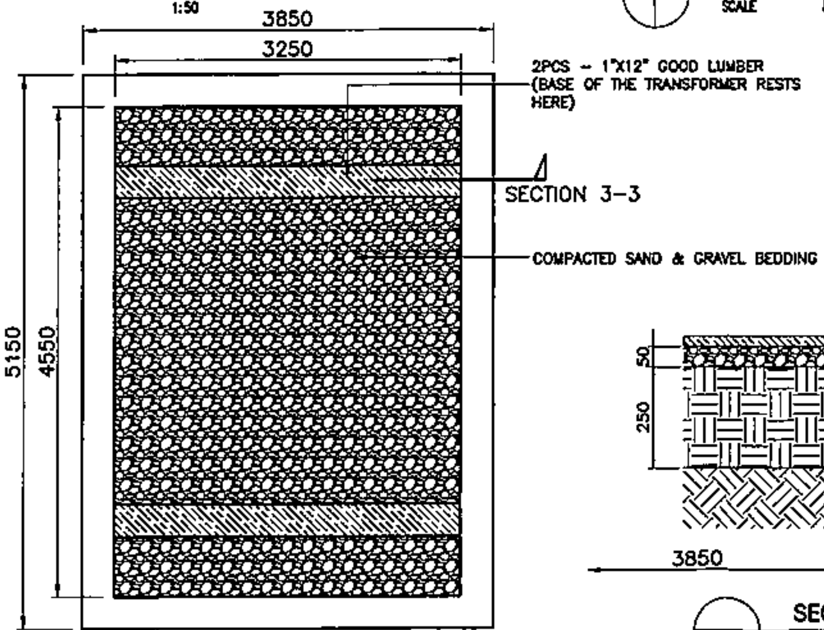
SECTION 1-1
SCALE NTS



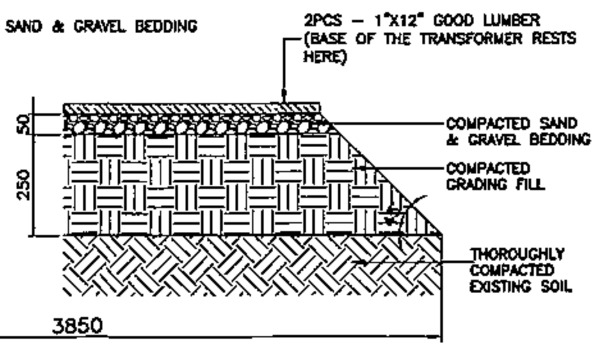
SECTION 2-2
SCALE NTS

D(mm)	S(mm)
500	150
600	125
700	100
800	100
900	75
1000	75

REBAR SPACING COMPARED TO DEPTH



TEMPORARY TRANSFORMER FOUNDATION PLAN
SCALE 1:50



SECTION 3-3
SCALE NTS

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETER UNLESS OTHERWISE INDICATED.
2. DEGREE OF COMPACTION OF GRADING FILL SHALL BE 95% OF RELATIVE DENSITY.
3. MINIMUM COMPRESSIVE STRENGTH OF CONCRETE SHALL BE f'c= 20.7 MPa (3000 psi) AT 28-DAY PERIOD.
4. REINFORCING STEEL BARS SHALL CONFORM TO THE LATEST REQUIREMENTS OF THE PNS FOR DEFORMED STEEL BARS GRADE 275.
5. ALL ASPECTS OF CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE PROVISIONS OF THE LATEST APPLICABLE CODE.
6. L_1 AND L_2 WILL BE BASED ON THE ACTUAL SIZE OF THE 10MVA TRANSFORMER TO BE SUPPLIED.
7. IN-SITU EXISTING SOIL SHALL BE THOROUGHLY COMPACTED.

REV.	DATE	NATURE OF REVISION	BY	CHKD.	RECO.	APPD.

OWNER: **NATIONAL POWER CORPORATION**
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: **TRANSFORMER PAD & TEMPORARY FOUNDATION**
(DETAILS & SECTIONS)

	BY	CHKD	DATE
DESIGNED			
DRAWN			
REVIEWED	PRINCIPAL ENGR./ARCHT.		
CIVIL/ARCH'T			
ELEC.			
MECH.			

SUBMITTED: H. L. MENDOZA
RECOMMENDED: A. C. ESPIRITU
APPROVED: R. G. [illegible]

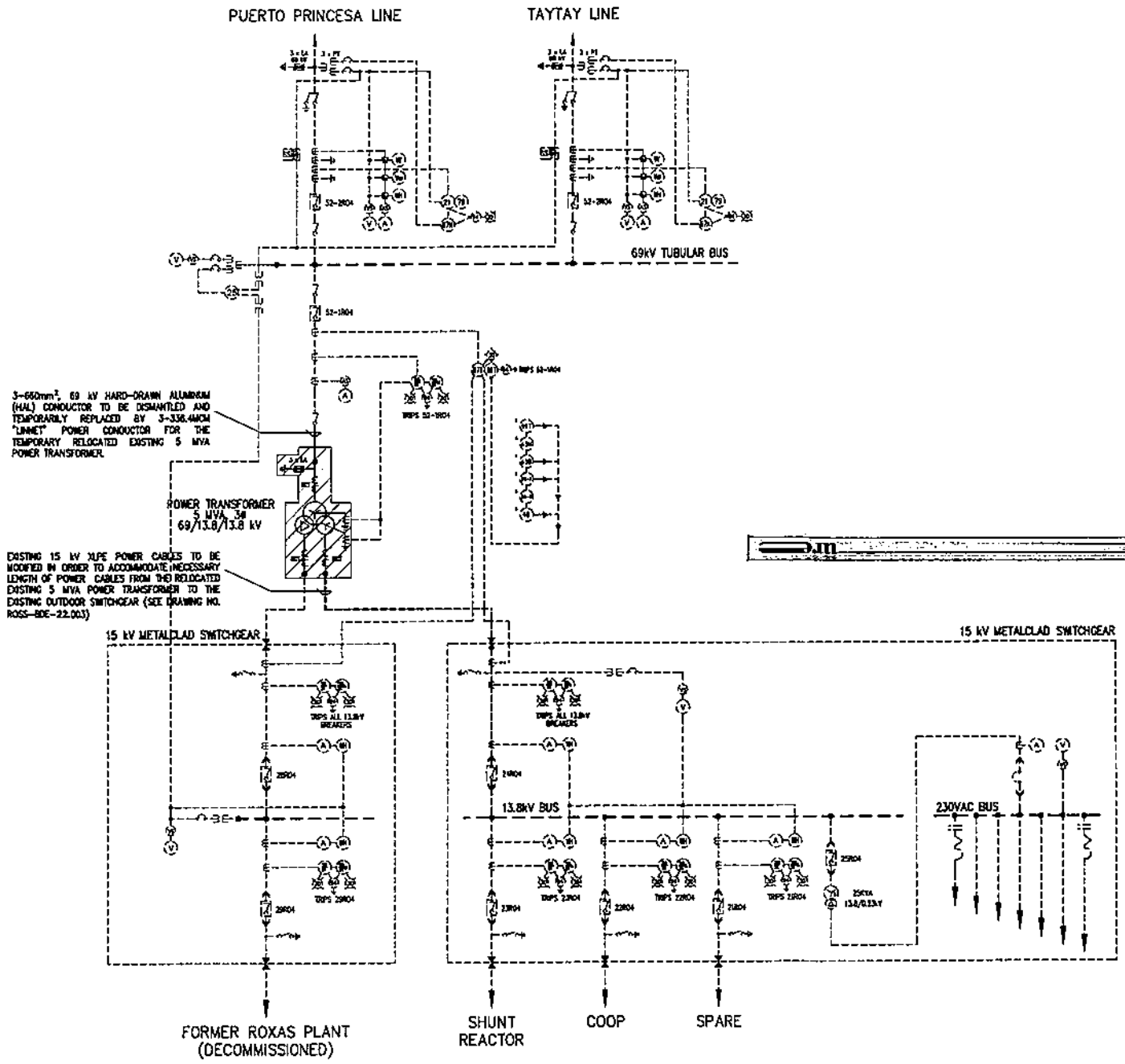
DWG. NO. ROSS-BDC-22.002 SPECS. NO. LuzP22Z1447Se

SCALE: AS SHOWN **BID DRAWING** REV. 0

BID DRAWINGS

ELECTRICAL WORKS

TABLE OF CONTENTS



NOTES:

1. ALL EQUIPMENT/MATERIALS DRAWN IN HIDDEN LINES ARE EXISTING.
2. THE CONTRACTOR SHALL DISMANTLE AND RELOCATE THE EQUIPMENT SHOWN INSIDE THE SHADED PORTION TO A TEMPORARY LOCATION IN ORDER TO PREVENT LONGER OR FREQUENT POWER INTERRUPTION DURING THE IMPLEMENTATION OF THE PROJECT. THE CONTRACTOR SHALL DETERMINE THE TEMPORARY LOCATION BASED ON ACTUAL CONDITIONS OF THE SITE.
3. THE CONTRACTOR SHALL DESIGN AND PROVIDE TEMPORARY RECEIVING POLE STRUCTURES FOR 69KV/15KV LINE CONDUCTORS/POWER CABLES FOR THE TEMPORARY RELOCATED EXISTING 5 MVA POWER TRANSFORMER.
4. THE CONTRACTOR IS REQUIRED TO PROVIDE ALL NECESSARY MATERIALS, TOOLS AND WORKS TO MAKE THE PROJECT FUNCTION PROPERLY.
5. THE CONTRACTOR IS REQUIRED TO CONDUCT SITE INSPECTION TO DETERMINE THE EXTENT OF WORK NEEDED FOR THIS PROJECT.

LEGENDS:

87T	– TRANSFORMER DIFFERENTIAL RELAY
86T	– TRANSFORMER LOCK-OUT RELAY
50/51	– PHASE OVERCURRENT RELAY
50/51N	– RESIDUAL OVERCURRENT RELAY
67N	– DIRECTIONAL OVERCURRENT RELAY
21/79	– DISTANCE PROTECTION WITH RECLOSING RELAY
25/SS	– SYNCHRONISING SWITCH
25	– SYNCHRONISING RELAY
94	– AUXILIARY TRIPPING RELAY
30	– ANNUNCIATOR/ALARM
BCT	– BUSHING CURRENT TRANSFORMER
LA	– LIGHTNING ARRESTER
52-XR04	– CIRCUIT BREAKER 69 KV, 2000A, 25 kA
2XR04	– CIRCUIT BREAKER 24 KV, 630A, 12.5 KA

DETAILS OF EXISTING 5 MVA POWER TRANSFORMER FOR MOUNTING:

MANUFACTURER: ABB		YEAR MANUFACTURE: 1994	
SERIAL NO.	53,972	FREQUENCY:	60 HZ
NO. OF PHASE:	3	RATED POWER:	5000 KVA
TEMPERATURE RISE:			
WINDING: 65 °C		OIL: 60 °C	
AMBIENT TEMPERATURE: 40 °C		TYPE OF COOLING: ONAN	
VOLTAGE LEVEL:		H – WINDING:	69,000
X – WINDING:	13,800	Y – WINDING:	13,800
MASSES (KGS)			
TOTAL:	17,440	OIL WEIGHT:	4,360
TRANSPORT WEIGHT (WITH OIL):		15,680	

OWNER: **NATIONAL POWER CORPORATION**
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: **SINGLE LINE DIAGRAM (1/2)**
(WITH THE EXISTING 5 MVA POWER TRANSFORMER)

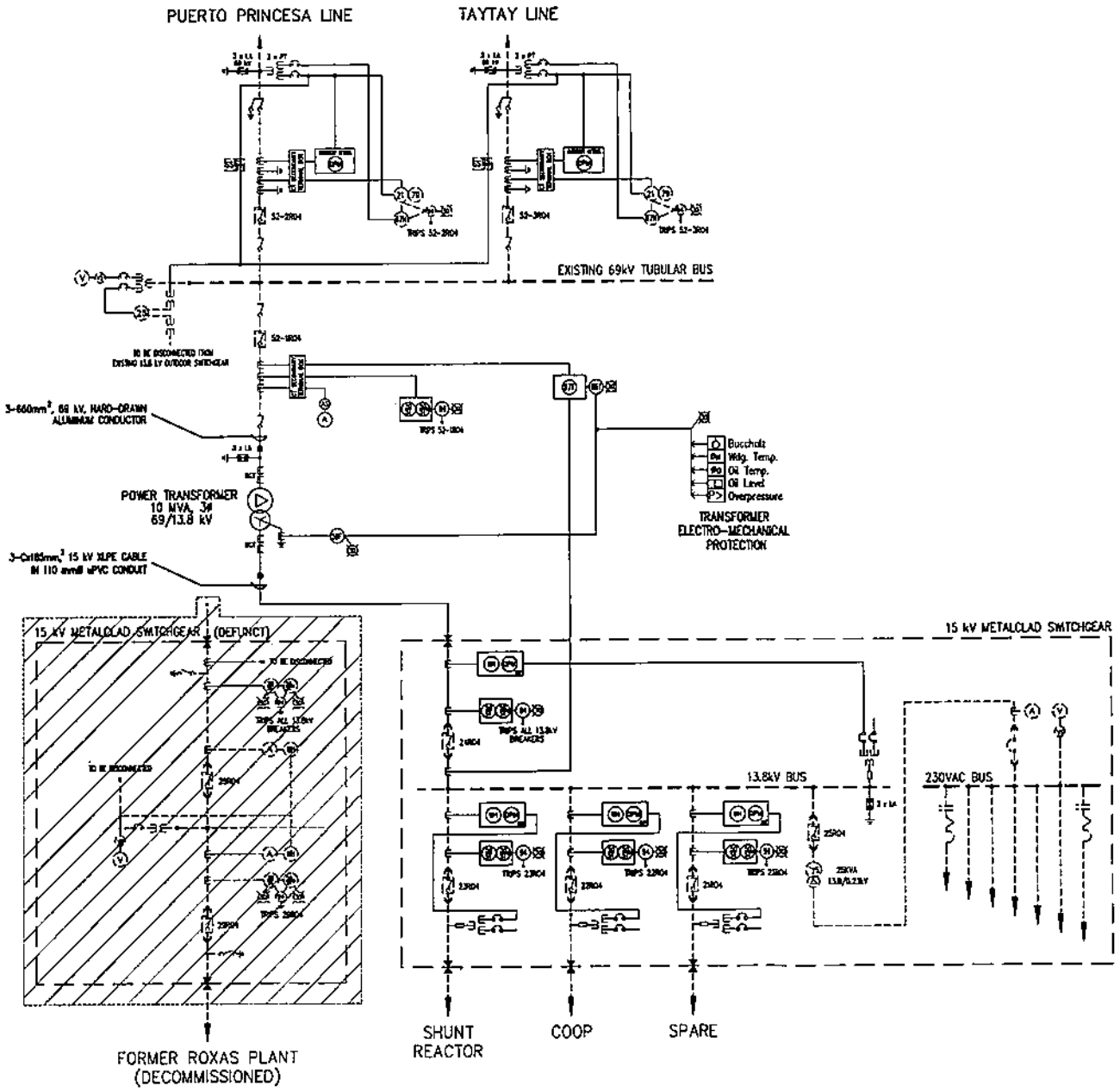
	BY	CHKD	DATE
DESIGNED			
DRAWN	AMP		
REVIEWED	PRINCIPAL ENGR. / ARCHT.		
CIVIL/ARCHT			
ELEC.	ILRP		
MECH.			

SUBMITTED: R. P. VERAR
RECOMMENDED: C. Z. C. LUGOD, JR.
APPROVED:

DWG. NO. ROSS-BDE-22.001 SPECS. NO. LuzP2221447Se

SCALE: NTS **BID DRAWING** REV. 0

REV.	DATE		BY	CHKD.	RECO.	APPD.



NOTES:

1. ALL EQUIPMENT/MATERIALS DRAWN IN HIDDEN LINES ARE EXISTING.
2. ALL EXISTING ELECTROMECHANICAL METERING DEVICES AND ANALOG MONITORING DEVICES SHALL BE DISMANTLED AND REPLACED WITH DIGITAL METERS.
3. ALL EXISTING TEST BLOCKS, TERMINAL BLOCKS, INSTRUMENT TRANSFORMERS AND OTHER APPURTENANCES FOR PROTECTION, MONITORING AND METERING DEVICES SHALL BE DISMANTLED AND REPLACED.
4. ALL EXISTING INSTRUMENTATION AND CONTROL CABLES OF SUBSTATION EQUIPMENT/DEVICES SHALL ALSO BE REPLACED.
5. ALL EXISTING FEEDER PROTECTION ELECTROMECHANICAL RELAYS OF 13.8 KV OUTDOOR SWITCHGEAR SHALL BE DISMANTLED AND REPLACED BY DIGITAL RELAYS.
6. ALL EQUIPMENT DRAWN INSIDE SHADED PORTION SHALL BE DISCONNECTED AS SHOWN.
7. THE CONTRACTOR IS REQUIRED TO PROVIDE ALL NECESSARY MATERIALS, TOOLS AND WORKS TO MAKE THE PROJECT FUNCTION PROPERLY.
8. THE CONTRACTOR IS REQUIRED TO CONDUCT SITE INSPECTION TO DETERMINE THE EXTENT OF WORK NEEDED FOR THIS PROJECT.

LEGENDS:

87T	– TRANSFORMER DIFFERENTIAL RELAY
86T	– TRANSFORMER LOCK-OUT RELAY
50/51	– PHASE OVERCURRENT RELAY
50/51N	– RESIDUAL OVERCURRENT RELAY
67N	– DIRECTIONAL OVERCURRENT RELAY
21/79	– DISTANCE PROTECTION WITH RECLOSING RELAY
25/SS	– SYNCHRONISING SWITCH
25	– SYNCHRONISING RELAY
94	– AUXILIARY TRIPPING RELAY
30	– ANNUNCIATOR/ALARM
BCT	– BUSHING CURRENT TRANSFORMER
LA	– LIGHTNING ARRESTER
52-XR04	– CIRCUIT BREAKER 69 KV, 2000A, 25 kA
2XR04	– CIRCUIT BREAKER 24 KV, 630A, 12.5 KA

OWNER: NATIONAL POWER CORPORATION
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

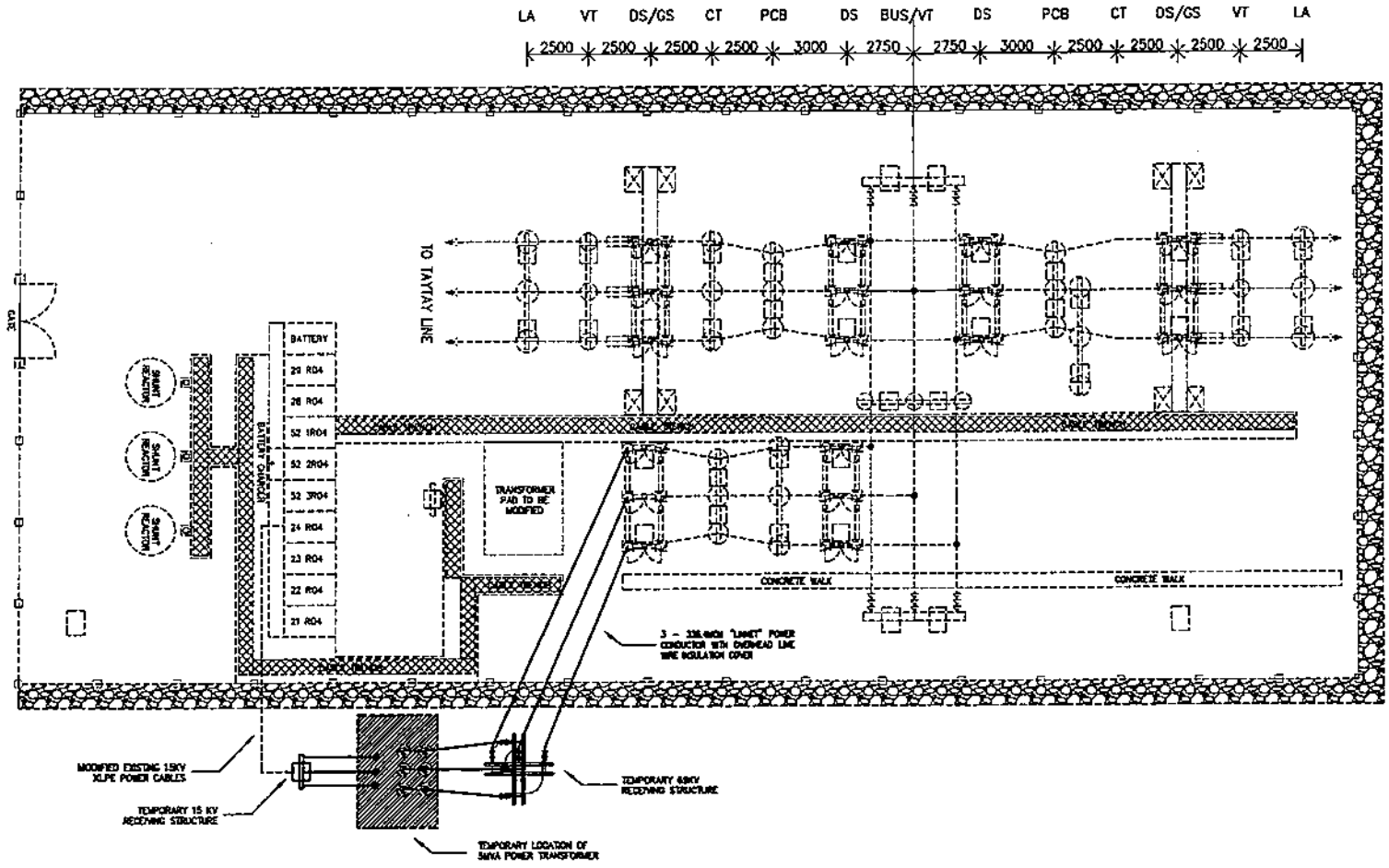
TITLE: SINGLE LINE DIAGRAM (2/2)
(WITH THE NEW 10 MVA POWER TRANSFORMER)

	BY	CHKD	DATE
DESIGNED	GP		
DRAWN	MP		
REVIEWED	PRINCIPAL ENGR. / ARCHT.		
CIVIL/ARCHT			
ELEC.	MJP		
MECH.			

SUBMITTED: R.P. VERAR
RECOMMENDED: C. Z. C. LUGOD, JR.
APPROVED: M.G. [illegible]

DWG. NO. ROSS-BDE-22.002
SPECS. NO. LuzP22Z1447Se
SCALE: NTS
BID DRAWING
REV. 0

REV.	DATE		BY	CHKD.	RECD.	APPD.



PROPOSED UPGRADING SCHEME DURING PROJECT IMPLEMENTATION

NOTES:

1. THIS DRAWING IS FOR BIDDING PURPOSES ONLY.
2. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE INDICATED.
3. ALL EQUIPMENT/MATERIALS DRAWN IN HIDDEN LINES ARE EXISTING.
4. ALL EQUIPMENT/MATERIALS DRAWN IN SOLID LINES ARE INCLUDED IN THE CONTRACT.
5. THE CONTRACTOR SHALL DISMANTLE AND RELOCATE THE EXISTING 5 MVA POWER TRANSFORMER TO A TEMPORARY LOCATION IN ORDER TO PREVENT LONGER OR FREQUENT POWER INTERRUPTION DURING THE IMPLEMENTATION OF THE PROJECT. THE CONTRACTOR SHALL ALSO DETERMINE THE TEMPORARY LOCATION BASED ON ACTUAL CONDITIONS OF THE SITE.
6. THE CONTRACTOR SHALL DESIGN AND PROVIDE TEMPORARY RECEIVING POLE STRUCTURES FOR 69KV/15KV LINE CONDUCTORS/POWER CABLES FOR THE TEMPORARY RELOCATED EXISTING 5 MVA POWER TRANSFORMER.
7. THE RELOCATED 5MVA POWER TRANSFORMER SHALL BE EARTH AT TWO POINTS DIAGONALLY OPPOSITE TO EACH OTHER USING GROUNDING RODS AND 100MM^2 INSULATED COPPER CONDUCTOR.
8. THE 69KV AND 15KV RECEIVING STRUCTURES SHALL BE PROPERLY GROUNDED USING GROUNDING RODS AND 100MM^2 INSULATED COPPER CONDUCTOR.
9. FOR GROUNDING DETAILS, SEE DETAIL "D" OF DRAWING NO. ROSS-BDE-22.006.
10. GROUNDING CONDUCTOR SHALL BE EMBEDDED AT LEAST 0.6M.
11. AFTER ERECTION/INSTALLATION OF 10 MVA POWER TRANSFORMER AND OTHER APPURTENANCES, THE CONTRACTOR SHALL DISMANTLE AND HAUL THE RELOCATED 5 MVA POWER TRANSFORMER TOGETHER WITH 15 KV AND 69 KV RECEIVING POLE STRUCTURES, ALUMINUM CONDUCTORS, 15KV XLPE POWER CABLES AND OTHER ACCESSORIES/APPURTENANCES WHICH WERE USED FOR TEMPORARY RELOCATION OF 5 MVA POWER TRANSFORMER TO ROXAS SUBSTATION STOCKYARD.
12. THE CONTRACTOR IS REQUIRED TO PROVIDE ALL NECESSARY MATERIALS, TOOLS AND WORKS TO MAKE THE PROJECT FUNCTION PROPERLY.
13. THE CONTRACTOR IS REQUIRED TO CONDUCT SITE INSPECTION TO DETERMINE THE EXTENT OF WORK NEEDED FOR THIS PROJECT.

REV.	DATE	BY	CHKD.	RECD.	APPD.

OWNER: **NATIONAL POWER CORPORATION**
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: **PROPOSED UPGRADING SCHEME**
(RELOCATION OF EXISTING 5MVA POWER TRANSFORMER)

	BY	CHKD	DATE
DESIGNED	AAP		
DRAWN	AAP		
REVIEWED	PRINCIPAL ENGR./ARCHT.		
CIVIL/ARCHT			
ELEC.	MJRP		
MECH.			

SUBMITTED: F. P. VERAR, Supvg. Engineer A, RECO

RECOMMENDED: C. Z. C. LUGOD, JR., Manager, RECO

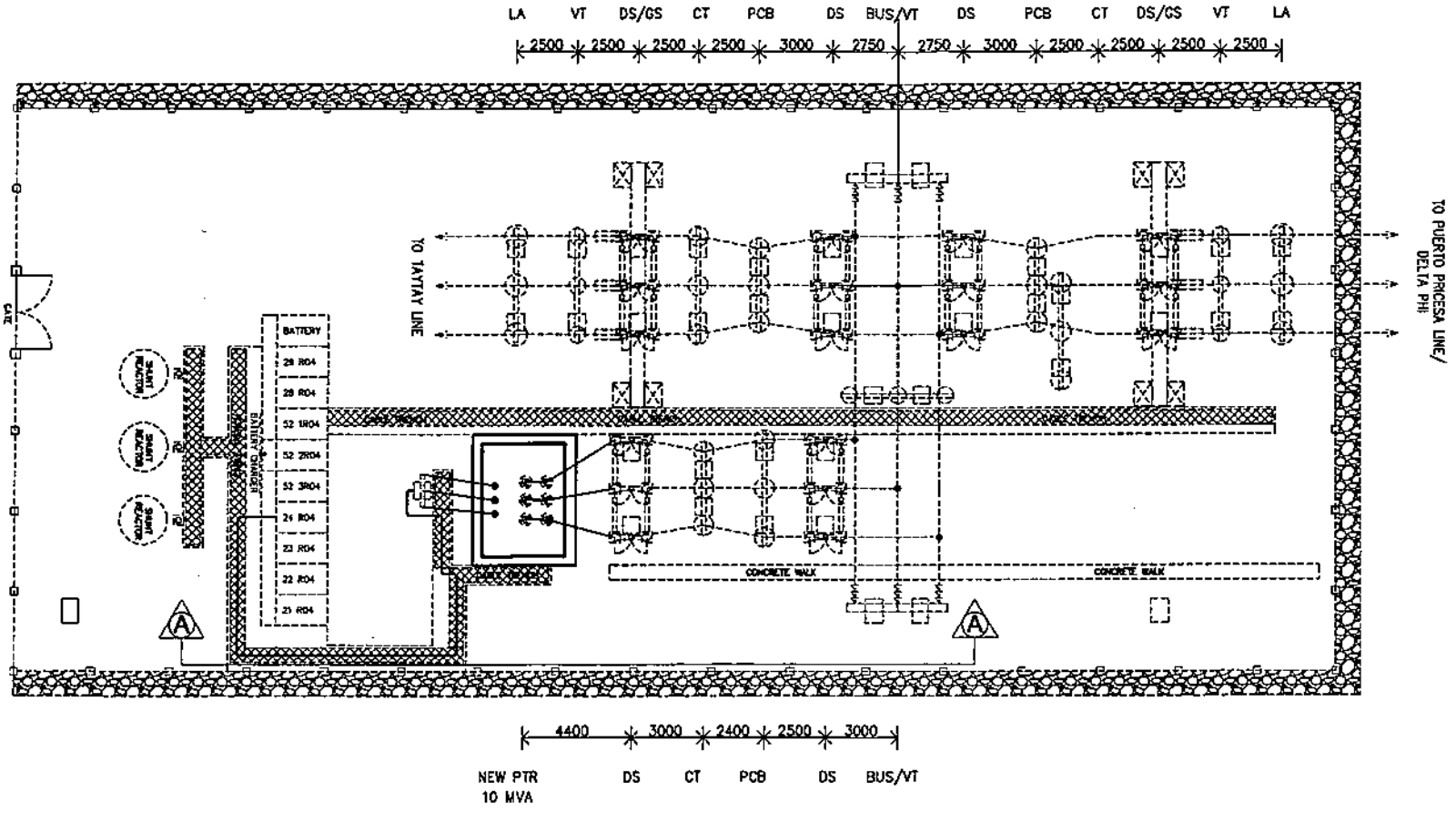
APPROVED: N. G. SOMBILLA, Manager, DDO

DWG. NO. ROSS-BDE-22.003 SPECS. NO. LuzP22Z144TSe

SCALE: NTS **BID DRAWING** REV. 0

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE INDICATED.
2. ALL EQUIPMENT/MATERIALS DRAWN IN HIDDEN LINES ARE EXISTING.
3. ALL EQUIPMENT/MATERIALS DRAWN IN SOLID LINES ARE INCLUDED IN THE CONTRACT.
4. THE CONTRACTOR IS REQUIRED TO PROVIDE ALL NECESSARY MATERIALS, TOOLS AND WORKS TO MAKE THE PROJECT FUNCTION PROPERLY.
5. THE CONTRACTOR IS REQUIRED TO CONDUCT SITE INSPECTION TO DETERMINE THE EXTENT OF WORK NEEDED FOR THIS PROJECT.



SUBSTATION EQUIPMENT LAYOUT

OWNER: NATIONAL POWER CORPORATION
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: SUBSTATION EQUIPMENT LAYOUT (WITH NEW 10 MVA POWER TRANSFORMER)

	BY	CHKD	DATE
DESIGNED			
DRAWN	AMP		
REVIEWED	PRINCIPAL ENGR. / ARCHT.		
CIVIL/ARCHT			
ELEC.	MJRP		
MECH.			

SUBMITTED: R. P. VERAR, Project Engineer A, EEDD

RECOMMENDED: C. Z. C. LUGOD, JR., Manager, EEDD

APPROVED: N. G. [illegible], Manager, DDD

DWG. NO. ROSS-BDE-22.004

SPECS. NO. Luz'P2221447Se

SCALE: 1:200

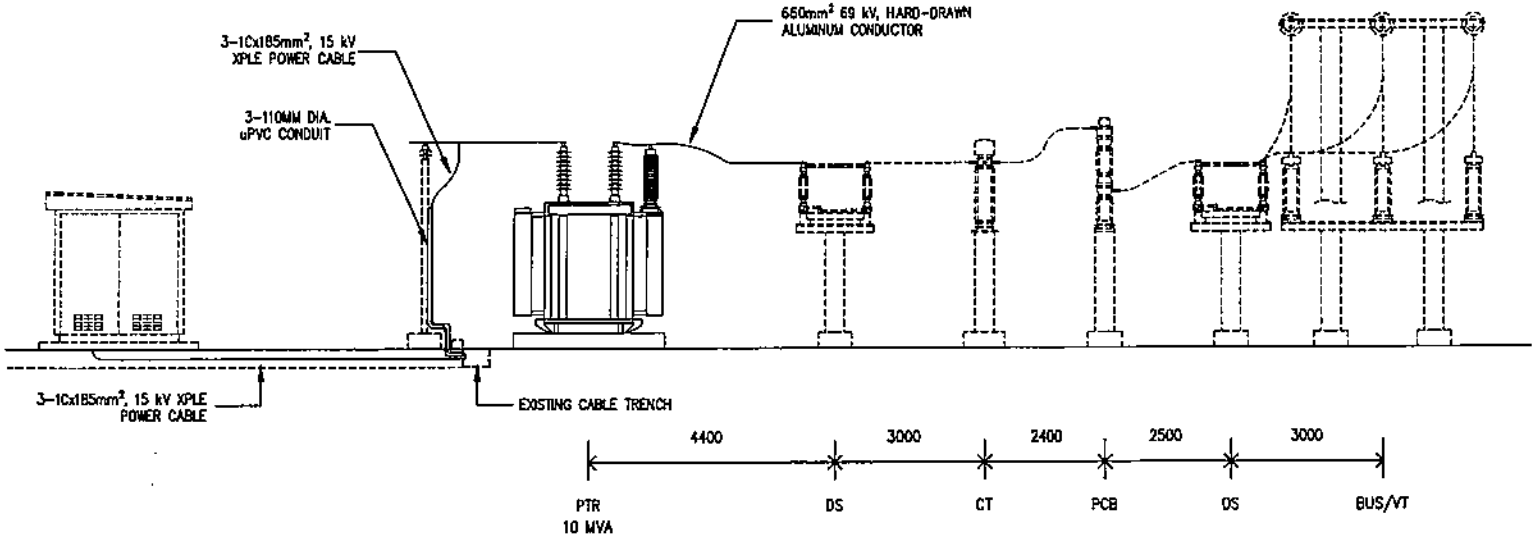
BID DRAWING

REV. 0

REV.	DATE		BY	CHKD.	RECD.	APPD.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE INDICATED.
2. ALL EQUIPMENT/MATERIALS DRAWN IN HIDDEN LINES ARE EXISTING.
3. ALL EQUIPMENT/MATERIALS DRAWN IN SOLID LINES ARE INCLUDED IN THE CONTRACT.
4. THE CONTRACTOR IS REQUIRED TO PROVIDE ALL NECESSARY MATERIALS, TOOLS AND WORKS TO MAKE THE PROJECT FUNCTION PROPERLY.
5. THE CONTRACTOR IS REQUIRED TO CONDUCT SITE INSPECTION TO DETERMINE THE EXTENT OF WORK NEEDED FOR THIS PROJECT.



SECTION A - A

OWNER: NATIONAL POWER CORPORATION
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: SECTION (WITH NEW 10 MVA POWER TRANSFORMER)

	BY	CHKD	DATE
DESIGNED			
DRAWN	AMP		
REVIEWED	PRINCIPAL ENGR. / ARCHT.		
CIVIL/ARCHT			
ELEC.	MJRP		
MECH.			

SUBMITTED: R. P. VERAR, Supervising Engineer A, DDD

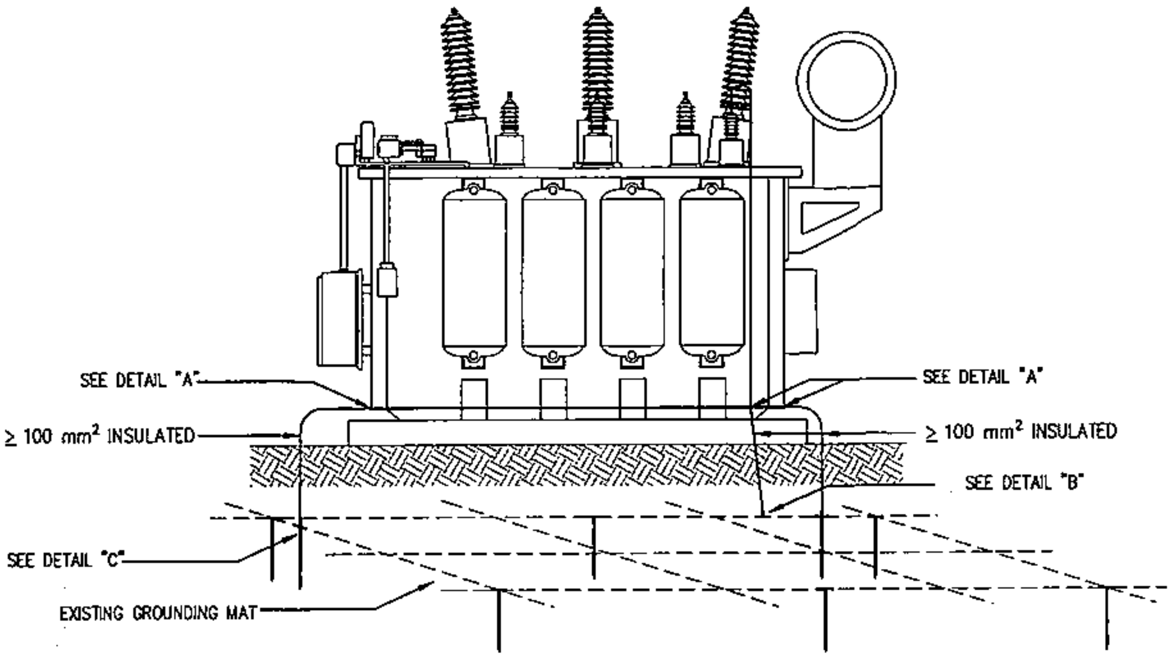
RECOMMENDED: C. Z. C. LUGOD, JR., Manager, DDD

APPROVED: N. G. SOLIVEREZ, Manager, DDD

DWG. NO. ROSS-BDE-22.005 | SPECS NO. LuzP22Z1447Se

SCALE: NTS | BID DRAWING | REV. 0

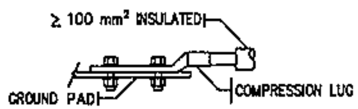
REV.	DATE		BY	CHKD.	RECD.	APPD.



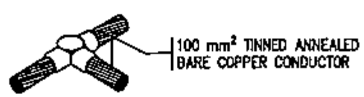
POWER TRANSFORMER GROUNDING SYSTEM DETAILS

NOTES:

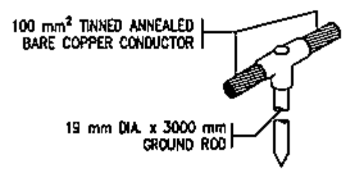
1. THIS DRAWING IS TENTATIVE AND FOR BIDDING PURPOSES ONLY.
2. ALL MATERIALS DRAWN IN HIDDEN LINES ARE EXISTING.
3. PRIOR INSTALLATION OF THE NEW TRANSFORMER, THE CONTRACTOR IS REQUIRED TO CONDUCT A GROUND GRID RESISTANCE TEST FOR THE EXISTING SUBSTATION. GROUND GRID RESISTANCE SHALL BE OF ≤ 0.5 OHMS. IF THE MEASURED RESISTANCE IS HIGHER THAN 0.5 OHMS, THE CONTRACTOR SHALL INSTALL ADDITIONAL GROUNDING RODS, MATS, ETC. UNTIL THE FIELD-MEASURES RESISTANCE IS EQUAL TO OR LESS THAN THE SPECIFIED VALUE. INITIAL AND FINAL GROUND GRID RESISTANCE TEST RESULT SHALL BE SUBMITTED FOR NPC'S APPROVAL.
4. POWER TRANSFORMER TANKS SHALL BE EARTHED AT TWO POINTS DIAGONALLY OPPOSITE TO EACH OTHER.
5. POWER TRANSFORMER EARTHING NEUTRAL SHALL BE EARTHED TO TWO DIFFERENT POINTS OF THE GRID. THE TRANSFORMER EARTHING STRIP SHALL BE ≥ 100mm² IN COPPER.
6. OTHER EQUIPMENT NOT SHOWN BUT REQUIRED TO BE GROUNDED AS PER NPC SPECIFICATIONS SHALL BE CONNECTED TO THE GROUNDING MAT.
7. LOCATION OF THE NEUTRAL TERMINAL ARE TENTATIVE. FINAL ARRANGEMENT SHALL DEPEND ON THE FINAL LAYOUT OF THE SUBSTATION EQUIPMENT TO BE SUPPLIED.



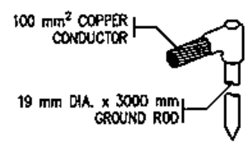
DETAIL - A



DETAIL - B



DETAIL - C



DETAIL - D

DETAILS OF GROUNDING SYSTEM CONNECTIONS

REV.	DATE		BY	CHKD.	RECD.	APPD.

OWNER: **NATIONAL POWER CORPORATION**
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

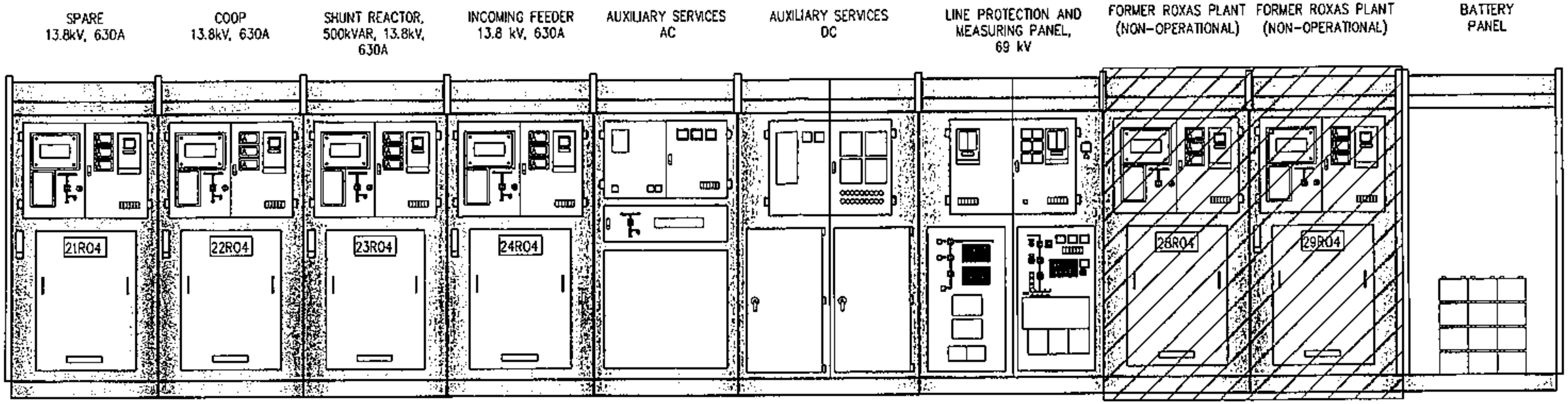
TITLE: **GROUNDING SYSTEM** (TYPICAL INSTALLATION DETAILS)

	BY	CHKD	DATE
DESIGNED	gp		
DRAWN	AIP		
REVIEWED	PRINCIPAL ENGR. / ARCHT.		
CIVIL/ARCHT			
ELEC.	MRP	[signature]	
MECH.			

SUBMITTED: R.P. VERAR
RECOMMENDED: E. Z. C. LUGOD, JR.
APPROVED: N. G. [illegible], Manager, DDD

DWG. NO. **ROSS-BDE-22.006** | SPECS. NO. LuzP22Z1447Se

SCALE: NTS | **BID DRAWING** | REV. 0



NOTES:

1. THIS DRAWING IS FOR REFERENCE PURPOSES ONLY.
2. ALL EQUIPMENT SHOWN INSIDE SHADED PORTION SHALL BE DISCONNECTED FROM THE SYSTEM AS SHOWN IN DRAWING NO. ROSS-BDE-22.002.
3. ALL EXISTING ELECTROMECHANICAL METERING DEVICES AND ANALOG MONITORING DEVICES SHALL BE DISMANTLED AND REPLACED BY DIGITAL METERS IN ACCORDANCE WITH THE DRAWING NO. ROSS-BDE-22.002.
4. ALL EXISTING TEST BLOCKS, TERMINAL BLOCKS, INSTRUMENT TRANSFORMERS, AND OTHER APPURTENANCES FOR PROTECTION, MONITORING AND METERING DEVICES SHALL BE DISMANTLED AND REPLACED WITH NEW.
5. ALL EXISTING FEEDER PROTECTION – ELECTROMECHANICAL RELAYS OF 13.8 KV OUTDOOR SWITCHGEAR SHALL BE DISMANTLED AND REPLACED BY DIGITAL RELAYS.
6. THE CONTRACTOR SHALL MODIFY THE EXISTING SWITCHGEAR PANEL FOR PROPER INTERFACING OF NEW DIGITAL METERING AND MONITORING DEVICES, DIGITAL RELAYS, ETC.
7. BATTERY BANK AND BATTERY CHARGER SHALL BE REPLACED WITH NEW IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS AND TECHNICAL DATA SHEETS.
8. THE CONTRACTOR SHALL UTILIZE AND MODIFY THE EXISTING BATTERY CHARGER PANEL TO ACCOMMODATE THE SPACE REQUIREMENT OF THE NEW BATTERY CHARGER. THE NEW BATTERY CHARGER SHALL BE FULLY INTEGRATED, RETROFITTED, AND INTERFACED TO MATCH THE EXISTING BATTERY CHARGER CONFIGURATION SETTINGS.
9. ALL MODIFICATION WORKS SHALL BE SUBJECT TO APPROVAL OF NPC.
10. THE CONTRACTOR IS REQUIRED TO PROVIDE ALL NECESSARY MATERIALS, TOOLS AND WORKS TO MAKE THE PROJECT FUNCTION PROPERLY.

REV.	DATE		BY	CHKD.	RECD.	APPD.

OWNER: **NATIONAL POWER CORPORATION**
AGHAM ROAD, DILIMAN, QUEZON CITY

PROJECT: UPGRADING OF EXISTING POWER TRANSFORMER FROM 5 MVA TO 10 MVA AND OTHER APPURTENANCES IN ROXAS SUBSTATION

LOCATION: ROXAS, PALAWAN

TITLE: **EXISTING 13.8 KV OUTDOOR SWITCHGEAR PANEL LAYOUT**

	BY	CHKD	DATE
DESIGNED			
DRAWN	AMP		
REVIEWED	PRINCIPAL ENGR./ARCHT.		
CIVIL/ARCHT			
ELEC.	MJRP		
MECH.			

SUBMITTED: R. P. VERAR, Principal Engineer A, EDCD
RECOMMENDED: E. Z. C. LUGOD JR., Manager, EDCD
APPROVED: N. G. SOMBRERRA, Manager, DDD

DWG. NO. **ROSS-BDE-22.007** SPECS. NO. LuzP22Z1447Se

SCALE: NTS **BID DRAWING** REV. 0