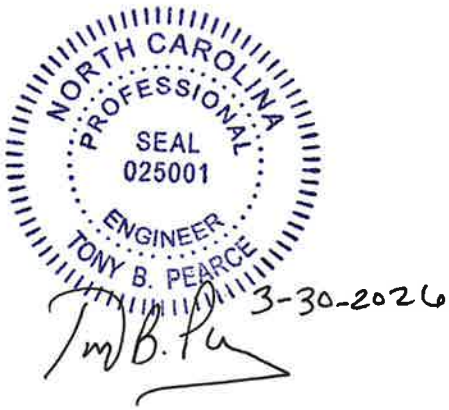
Town of Smithfield
Smithfield, North Carolina

Hospital Road Substation
Specifications and Bid Documents
For
Outdoor Power Transformer



ECE

ECEPOWER.COM

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Town of Smithfield
Smithfield, North Carolina

Hospital Road Substation
Specifications and Bid Documents
for
Outdoor Power Transformer

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BID SCHEDULE

NOTICE TO PROSPECTIVE BIDDERS

Invitation to Submit Proposals
to

TOWN OF SMITHFIELD
SMITHFIELD, NORTH CAROLINA

In Accordance With
Procurement Documents
For

Outdoor Power Transformer

1.0 Sealed Proposals to furnish specified materials and services for Outdoor Power Transformer will be received by the Town of Smithfield, Smithfield, North Carolina until **2:00 pm, local time May 12, 2026,** at which time all bids will be publicly opened and read at the Town of Smithfield Utilities Operations Building.

2.0 It is the sole responsibility of the Bidder to ensure delivery of the bid at the designated place and time. Late delivery of bids for any reason including delivery by the USPS or by other courier shall disqualify the bid. All proposals received after the designated time for bid opening will be considered invalid and promptly returned to the Bidder unopened.

3.0 Proposals must be submitted in a sealed envelope bearing the name and address of the bidder. Proposals should be delivered to the following address:

Ted Credle, P.E.
Director of Public Utilities
Town of Smithfield
230 Hospital Road
Smithfield, NC 27577

4.0 Proposals transmitted via facsimile (fax) or e-mail directly to the Town will not be considered sealed bids and will be rejected.

5.0 Bidders shall clearly identify their proposal as a sealed bid by including the following text on a conspicuous area of the envelope:

"PROPOSAL FOR OUTDOOR POWER TRANSFORMER. DO NOT OPEN UNTIL 2:00 P.M., May 12, 2026 ".

6.0 All proposals (2 copies) must be submitted on the appropriate preprinted quotation forms (Bid Schedule) provided in these Procurement Documents. All blank spaces for bids, unit prices, completion time etc. shall be filled in unless otherwise noted. Failure to provide all requested information may result in the bid being considered incomplete. The Bidder's quotations and data on these forms must either be typewritten or hand written in permanent ink. Any alterations to these entries must be initialed and dated by the authorized agent for the bidder. The bidder shall submit the Proposal and Contract Section, completed Bid Schedule and any supporting documentation. The Bidder does not need to return a copy of the procurement documents nor technical specifications.

7.0 No alterations, corrections, or modifications to any proposal will be allowed after bids have been

received and opened. However, the bidder may submit modifications in writing prior to the time of bid opening under sealed envelope bearing the bidder's name and address. Such modifications shall be clearly identified as an amendment to a pending proposal by including the following text on a conspicuous area of the envelope:

"AMENDMENT TO PROPOSAL OUTDOOR POWER TRANSFORMER DO NOT OPEN UNTIL 2:00 P.M., May 12, 2026".

8.0 All supporting documentation as may be required by the Specifications must be submitted at the time of bid and included with the sealed proposal. If a manufacturer is submitting proposals through more than one Bidder, the supporting documentation may be submitted directly by the manufacturer in a separately sealed envelope. The envelope must bear the names of the Bidders to whom the literature applies. Conversely, the corresponding Bidders must clearly identify and refer to the separately sealed manufacturer's literature.

9.0 No bid may be altered, withdrawn, or resubmitted within **60** days from and after the date set for the bid opening. All bids shall remain firm and binding proposals during this period.

10.0 The bidder bears responsibility to comprehend the project work and to make all inquiries as necessary to achieve comprehension prior to submission of a sealed proposal. Submission of a proposal shall be evidence that the bidder has fully reviewed the scope of work and confident as to the content of the work requirements.

11.0 A copy of the Procurement Documents, including technical specifications and bid forms, are on file with the Town and are available for public review. Inquiries regarding technical aspects of the project work may be directed to the Town's consulting engineer. Additional copies of the Procurement Documents are also available from the Engineer. The Engineer may be contacted as follows:

Electrical Consulting Engineers
Attention: Tony B. Pearce, PE
Mobile: 919.632.7426
tpearce@ecepower.com

12.0 The Town reserves the right to reject any and all bids, and to waive minor errors in the bidder's proposal if the errors are deemed by the Town to be obviously inadvertent and do not affect the scope of work. If minor errors are evident in a proposal pending award of contract, the correction of these errors shall be resolved in writing to the satisfaction of the Town prior to execution of a contract.

13.0 Do not include NC sales tax in the bid amount. NC sales tax is paid by the Town and can be included on invoices.

14.0 Do not include Federal Excise Tax in bid amount. The Town will provide a Federal Exemption Certificate upon request.

Town of Smithfield
Smithfield, NC

By: Electrical Consulting Engineers

Date: March 30, 2026

INSTRUCTIONS TO BIDDERS

1.0 Bidder Qualifications

1.1 Determination of "Responsible Bidder" is based upon quality, performance, and time. The terms responsibility, quality, and performance are subjective and the Owner reserves the right to award the contract to a bidder based upon this criteria as deemed to best suit the needs of the Owner.

2.0 Obtaining Copies of Bidding Documents

2.1 Invitations to bid may be automatically forwarded to prospective bidders that have demonstrated "responsibility" in the past.

2.2 When extending invitations to bid, the Owner and the Owner's Engineer will make copies of the Procurement Documents available to all Bidders only for the purpose of obtaining bids for the stated materials and services and do not confer or grant a license for any other use. All Procurement Documents are instruments of service and remain the intellectual property of the Engineer whose name appears thereon.

2.3 Complete sets of the Procurement Documents may be obtained in the number and for the fee sum, if any, stated in the Notice to Bidders from the issuing office as named in the Notice to Bidders.

3.0 Submission of Proposals

3.1 Proposals must be submitted in accordance with the directives outlined in the Notice to Bidders and with the instructions contained herein to be considered for evaluation and award of contract. Failure to comply with requirements of the Notice to Bidders or these Instructions to Bidders may result in outright rejection of the proposal.

3.2 All proposals must be submitted on the appropriate preprinted quotation forms (Bid Schedule) provided in these Procurement Documents. The Bidder's quotations and data on these forms must either be typewritten or hand written in permanent ink. Any alterations to these entries must be initialed and dated by the authorized agent for the bidder.

3.3 The Bidder must fully complete all Bid Schedule forms and also adequately furnish all information requested by the Procurement Documents and the Technical Specifications regarding pricing, quantities, delivery, services, spare parts, descriptive information, etc. Failure to supply sufficient information may cause a bid to be rejected as unresponsive.

3.4 The Bidder must supply two (2) copies of the Proposal, including the original forms and one duplicate set of forms. Supplemental literature offered by the Bidder must be supplied in duplicate.

3.5 It is understood that by submitting a bid, the Bidder acknowledges that he has carefully examined the documents pertaining to the work, has understood same and is satisfied that he will, if successful, perform said work in accordance with the documents as well as any other rules, ordinances, codes, regulations, laws etc. pertaining thereto.

3.6 The Bidder must explicitly note all exceptions, clarifications, and deviations from the requirements of this specification by the products offered. Each notation must be referenced to the specific sections and paragraphs in question. The Table of Exceptions must be presented with the proposal at the time of bid opening. Failure to identify an exception, clarification, or deviation will be considered certification that all products and services perform in full compliance with the Procurement Documents. Substitution of the Bidders standard terms and conditions or other documents will not be construed as constituting an exception. Exceptions and deviations noted in the Bidder's Proposal will not necessarily eliminate a proposal from consideration. The impact of exceptions and deviations will be considered together with all factors of the bid when determining which proposal best represents the interests of the Owner.

3.7 Proposals must include a complete list of materials or "DELIVERABLES" to be furnished. The list of deliverables shall include quantities and model number identification where applicable.

3.8 Proposals must include a Delivery Schedule illustrating in either tabular or graphic form critical benchmarks for the production cycle of the materials and services offered. Chronological information should be identified in days or weeks as appropriate, from receipt of order to completion of all deliveries and field services.

3.9 No alterations, corrections, or modifications to any proposal will be allowed after bids have been received and opened. However, the bidder may submit modifications in writing prior to the time of bid opening under sealed envelope bearing the bidder's name and address. Such modifications shall be clearly identified as an amendment to a pending proposal by including text as designated in the Notice to Bidders on a conspicuous area of the envelope.

3.10 The Bidder shall sign the Proposal as follows:

3.10.1 If the documents are executed by a sole owner, that fact shall be evidenced by the word "owner" appearing after the name of the person.

3.10.2 If the documents are executed by a partnership that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing

them.

3.10.3 If the documents are executed on the part of a corporation they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary and the title of the office of such persons shall appear after their signatures, the seal of the corporation shall be impressed on each signature page.

3.10.4 If the proposal is made by a joint venture, it shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation which herein is applicable.

3.10.5 All signatures shall be properly witnessed.

3.10.6 Anyone signing the proposal as an agent shall file, with the proposal, legal evidence of his authority to do so.

4.0 Bid Security

Bid security is not required on this project.

5.0 Clarifications and Addenda

5.1 The bidder bears responsibility to comprehend the project work and to make all inquiries as necessary to achieve comprehension prior to submission of a sealed proposal. Submission of a proposal shall be evidence that the bidder has fully reviewed the scope of work and is confident as to the content of the work requirements. If the prospective bidder discovers discrepancies in the procurement documents or requires further clarification of their intent, the prospective bidder should immediately notify the Engineer. Significant clarification or corrections will be issued by the Engineer in writing to all prospective bidders by addendum.

5.2 Addenda officially issued by the Engineer and received by a prospective bidder prior to bid opening must be acknowledged by the bidder by including the addendum notice with the proposal. Forms of addenda will provide a space for bidder's signature to certify this acknowledgment.

5.3 Any contract awarded to a proposal shall include the conditions and/or clarifications set forth by the addenda.

5.4 Neither the Engineer nor the Owner will be held responsible for a bidder's interpretation of oral instruction.

6.0 Firm Bids Retained

6.1 Pricing and delivery for all proposals shall remain firm and valid for a minimum of sixty (60) days following the date and time of the bid opening.

7.0 Opening of Bids and Bid Evaluation

7.1 Bids will be received and opened in strict accordance with the requirements of the General Statutes of North Carolina. All bids will be opened publically and read aloud.

7.2 The proposal which, in the opinion of the Owner, best fulfills the technical, budgetary, chronological, and operational objectives of the project scope will be the recommended candidate for an award of contract. The Owner shall take into consideration past performance of the Bidder on Contracts of a similar nature with other utilities. Subsequent to the bid opening, the bidder may be required to furnish additional data or make plant facilities available for inspection to assist the Owner in evaluating the merits of a proposal. The Owner may award on the basis of the base bid and any alternates the Owner chooses.

7.3 The Owner reserves the right to reject any and all bids, and to waive minor errors in the bidder's proposal if the errors are deemed to be obviously inadvertent by the Owner and do not affect the scope of work. If minor errors are evident in a proposal pending award of contract, the correction of these errors shall be resolved in writing to the satisfaction of the Owner prior to execution of a contract.

7.4 If the contract is to be awarded, the Owner will give the recommended Bidder an Acceptance Notice within sixty (60) days after the bid opening date.

7.5 In the event that the recommended bidder fails to enter a contract, the next most favorable proposal will be considered for award of contract based upon firm quotations offered in the proposal.

GENERAL CONDITIONS

1.0 Intent of Procurement Documents

1.1 The Procurement Documents comprise the entire agreement between the Purchaser and the Seller concerning technical specifications and commercial arrangements for materials and services. The Procurement Documents are initially issued as an instrument for receiving bids from qualified Bidders and may at times be alternately referred to as Bidding Documents during the interim when invitations to bid have been extended. Once a successful Bidder is selected, the Procurement Documents constitute the Contract between the Purchaser and the Seller.

1.2 The Contract Documents may be altered only by the following:

1.1.1 Written addenda issued prior to bid opening and to be officially acknowledged by the prospective Bidder;

1.1.2 Written Change Order issued to the Seller by the Purchaser following the effective date of the Contract and authorizing specific additions, deletions, or revisions in materials and services, and authorizing specific adjustments in the Contract price or project schedule.

1.1.3 Written orders issued by the Engineer clarifying interpretation of the Procurement Documents and resulting in minor changes that do not affect the Contract price or project schedule.

1.3 The Procurement Documents are complementary; what is called for by one is binding as if called for by all.

1.4 All materials and services that may reasonably be inferred from the Procurement Documents as being required to produce the intended result will be supplied whether or not specifically called for.

1.5 Reference to standard specifications, manuals, or codes of any technical society, organization, or association, or to the code of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, or code in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provisions of any referenced standard specification, manual, or code shall change the duties and responsibilities of the Seller.

1.6 When words which have a well-known technical or trade meaning are used to describe materials, equipment, or services, such words will be interpreted in accordance with such meaning.

2.0 Ownership of Procurement Documents

2.1 When extending invitations to bid, the Purchaser and the Purchaser's Engineer will make copies of the Procurement Documents available to all qualified Bidders only for the purpose of obtaining bids for the stated materials and services and do not confer a license or grant for any other use. All Procurement Documents are instruments of service and remain the intellectual property of the Engineer whose name appears thereon.

2.2 Complete sets of the Procurement Documents in the number and for the fee sum, if any, stated in the Notice to Bidders may be obtained from the issuing office as named in the Notice to Bidders.

2.3 Complete sets of Procurement Documents must be used in preparing bids. Neither the Purchaser nor the Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Procurement Documents.

3.0 Discrepancies and Clarifications

3.1 If a prospective Bidder discovers discrepancies in the Procurement Documents or requires further clarification of their intent, the prospective Bidder should promptly notify the Engineer at the earliest discovery and prior to the bid date. Significant clarification or corrections will be issued by the Engineer to all prospective bidders by written addenda in the most time effective manner. Inquiries received less than seven days prior to the date of bid opening may not be answered. Only questions answered by formal written addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

3.2 If, during the performance of the Contract, the Seller finds a conflict, error, or discrepancy in the Contract Documents, the Seller shall so report to the Engineer in writing at once and shall obtain a written interpretation or clarification from the Engineer before proceeding further with those tasks which may be affected by the error, conflict, or discrepancy. The Engineer will issue with reasonable promptness written clarifications or interpretations as the Engineer may deem necessary regarding the requirements of the Contract Documents.

4.0 Insurance

4.1 The Seller shall maintain in force and effect the following types of insurance with coverage as indicated:

4.1.1 Worker's Compensation Insurance in the statutory amount.

4.1.2 Comprehensive General Liability Insurance of not less than $1,000,000 each occurrence and $3,000,000 aggregate, including Comprehensive Broad Form Endorsement, with Contractual Liability Coverage.

4.1.3 Automobile Liability Insurance of not less than $250,000 per person, $500,000 per occurrence bodily injury and $100,000 property damage.

4.2 The Seller shall provide notarized certification of the appropriate insurance stating to wit: "The policies of insurance described herein are hereby certified to have been issued to the insured for whom this certificate is executed and that these policies are in force at this time".

4.3 In the event of cancellation or material change in a policy affecting the certificate holder, the Seller shall provide 30 days written notice of such cancellation or material change to the Purchaser.

4.4 The Seller shall assume all risk of loss or damage to the materials prior to the acceptance of delivery by the Purchaser at the designated point of delivery, and shall purchase and maintain insurance on the materials during the process of fabrication and while in transit to insure against the perils of fire and extended coverage including "all risk" insurance for physical loss and damage including theft, vandalism and malicious mischief, collapse, water damage and such perils.

5.0 Patent Fees, Licenses, and Royalties

5.1 The Seller shall pay all license fees and royalties and assume all costs incident to the use in the production of materials or the incorporation in the materials of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others.

5.2 The Seller shall indemnify and hold harmless the Purchaser and the Engineer and anyone directly or indirectly employed by either of them from and against all claims, damages, losses, and expenses (including attorney's fees) arising out of any infringement of patent rights or copyrights incident to the use in production of the materials or incorporations therein of any invention, design, process, product, or device and shall defend all such claims in connection with any alleged infringement of such rights.

6.0 Indemnity

6.1 To the fullest extent permitted by Laws and Regulations, the Seller shall indemnify and hold harmless the Purchaser, the Engineer, the Engineer's Consultants and the officers, directors, employees, agents, and other consultants of each and any of them from and against all claims, damages, losses, and expenses (including but not limited to all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) caused by, arising out of, or resulting from performance of the Work, provided that any such claim, damage, loss, or expense:

a) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, and

b) is caused in whole or in part by any negligent act or omission of the Seller, any Subcontractor, any Supplier, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, regardless of whether or not caused in part by any negligence or omission of a person or entity indemnified hereunder or whether liability is imposed upon such indemnified party by Laws and Regulations regardless of the negligence of any such person or entity.

6.2 In any and all claims against the Purchaser or the Engineer or any of their respective consultants, agents, officers, directors, or employees by any employee (or the survivor or personal representative of such employee) of the Seller, any Subcontractor, any Supplier, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.1 shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Seller or any such Subcontractor, Supplier, or other person or organization under Workers Compensation Acts, disability benefit acts, or other employee benefit acts.

6.3 The indemnification obligations of the Seller under Paragraph 6.1 shall not extend to the liability of the Engineer and the Engineer's Consultants, officers, directors, employees, or agents caused by the professional negligence, errors, or omissions of any of them.

7.0 Assignments and Subcontractors

7.1 The Seller shall competently and efficiently direct procurement of materials and supervise services and coordinate all operations required to deliver the materials and services required by the Contract.

7.2 The Seller shall designate in writing to the Purchaser and the Engineer the name of the person authorized and assigned to act on the behalf of the Seller with respect to the Seller's obligations under the Contract Documents. All communications given to or received from that person will be binding on the Seller.

7.3 The Seller shall not assign any portion of the Contract nor subcontract the Contract Work in its entirety except as fully disclosed in the Proposal at the time of bid opening and as fully accepted by the Purchaser. No funds or sums of money due or to become due the Seller may be assigned under this Contract.

8.0 Contract Price and Change Orders

8.1 The Contract price constitutes the total compensation, excluding taxes, payable to the Seller for furnishing the specified materials and services in connection with performance of the Contract. All duties, responsibilities, and obligations assigned to or undertaken by the Seller shall be at his expense without change in the Contract price.

8.2 The Purchaser or the Engineer acting on the behalf of the Purchaser may make changes to the work defined by the Contract Documents after the award of the Contract or while the Seller's work is in progress. Where such changes result in an adjustment to the Contract price or project schedule, all parties including the Purchaser, the Engineer, and the Seller must formally concur on the amount of compensated adjustment prior to undertaking any changes in the contracted work. The formal agreement shall take the form of a Change Order.

8.3 If the Seller believes that compliance to written clarification or interpretation issued by the Engineer after award of the Contract justifies an increase in the Contract price or the Contract project schedule, the Seller may make a claim therefor under provisions for a Change Order. It is the Seller's responsibility to show cause for a Change Order claim and to provide all documentation to support the claim. The Purchaser or the Engineer on the Purchaser's behalf reserves the right to review, approve, or deny any Change Order adjustments requested by the Seller.

8.4 The Contract price shall not be altered without a fully executed Change Order nor will any payments be made to the Seller for any additional work performed without a fully executed Change Order authorizing such work.

9.0 Project Schedule and Extensions of Time

9.1 Time required for completion of the Contract shall be as stated in the Seller's proposal as submitted at the time of the bid opening. The Seller shall commence work in accordance with the project schedule upon receipt of a written Acceptance Notice from the Purchaser authorizing work to begin.

9.2 The Contract project schedule will be extended in an amount equal to time lost due to delays beyond the control of the Seller. Such delays may include, but are not limited to, acts of neglect by the Purchaser, changes issued by the Engineer, or to fires, flood, labor disputes, epidemics, abnormal weather conditions, governmental procedures, or acts of God.

9.3 The Seller must apply for extension to the Contract project schedule in writing to the Purchaser or the Purchaser's Engineer at earliest discovery of conditions which may cause a project delay. It is the Seller's responsibility to show cause for a schedule delay and to provide all documentation to support the claim. The Purchaser or the Engineer on the Purchaser's behalf reserves the right to review, approve, or deny any project schedule extensions requested by the Seller.

10.0 Quality and Workmanship

10.1 Unless otherwise specified, the materials incorporated into the Seller's work shall be new and of good quality. All services and workmanship shall be of good quality and free from defects.

10.2 The Seller shall, if required by the Engineer, furnish satisfactory evidence as to the source, kind and quality of the materials incorporated in the work.

10.3 All services provided by the Seller shall be performed by competent and qualified personnel.

10.4 The Seller shall provide the Engineer, the Engineer's representatives and other representatives of the Purchaser proper and safe access to materials in the process of production at reasonable times as is necessary for the performance of their function in connection with the Contract Documents.

10.5 On behalf of the Purchaser, the Engineer will have authority to disapprove or reject materials or services which are defective or lack compliance with the Contract Documents.

11.0 Delivery

11.1 Material components of the project shall be delivered to the person(s) and site(s) specifically designated as Point(s)-of-Delivery in the Technical Specifications and in accordance with the terms and conditions designated in the Technical Specifications.

11.2 All materials will be delivered F.O.B. point-of-delivery at the Seller's cost and risk of delivery.

11.3 The Seller shall confer property title on all materials to the Purchaser upon delivery to the designated person(s) and site(s). However, the Purchaser will not be obligated to accept any delivery of materials not made in accordance with the requirements noted in the Contract Documents. Unacceptable deliveries shall be returned at the expense of the Seller.

11.4 The Purchaser reserves the right to alter the designated delivery site(s) and to accelerate or postpone delivery dates by Change Order. If the Seller can show documented proof of additional costs incurred for such changes, the Seller may make claim for adjustments in Contract price for the changes in delivery.

12.0 Warranty and Guarantee

12.1 The Seller's obligation to provide materials and perform services in accordance with the Contract Documents is absolute, and the Seller warrants and guarantees to the Purchaser and to the Engineer that all materials and services will be in accordance with the Contract Documents and free from defects.

12.2 The Seller shall guarantee his Work against material defect and faulty workmanship and negligence for the period designated by the Technical Specifications or as elsewhere duly noted in the Contract Documents, commencing on the date of final acceptance of the Work by the Purchaser.

12.3 Materials supplied by the Seller but not manufactured by the Seller shall be guaranteed against defects in accordance with the warranty requirements of the Technical Specifications or as elsewhere duly noted in the Contract Documents, unless the manufacturer of origin's warranty exceeds the specified requirements, then the Seller's warranty shall be for a term equal to the warranty of the manufacturer.

12.4 The Purchaser shall be entitled to the benefits of all warranties provided on all materials and services supplied by the Seller, regardless of manufacturer or origin.

13.0 Remedying Faulty Work

13.1 If there are apparent defects in the materials supplied by the Seller, the Purchaser or the Engineer will give prompt written notice thereof to the Seller. The Seller shall without cost to the Purchaser correct the defect or replace the materials with non-defective or conforming materials and shall take action to do so within 14 days after receiving written notification of defects.

13.2 If the Seller fails to promptly correct defects to the satisfaction of the Purchaser and the Engineer, the Purchaser may elect to replace or correct defective materials and recover all expenses of replacement and correction with an appropriately corresponding reduction in the Contract price.

13.3 If, at any time, the Purchaser or the Engineer notifies the Seller in writing that any services provided by the Seller fail to meet performance standards set forth by the Procurement Documents and prudent judgment, the Seller shall promptly provide service of quality acceptable to the Purchaser and the Engineer.

13.4 If the Seller fails to promptly remedy faulty performance to acceptable standards, the Purchaser may elect to obtain acceptable services elsewhere at the expense of the Seller.

14.0 Application for Payments

14.1 Payments will be allowed by the Purchaser to the Seller, based upon the Contract amount and successful completion of the project milestones specifically noted herein.

Receipt of final drawings and documentation:	0% of Contract Amount
Receipt of materials and services:	90% of Contract Amount
Final Inspection and Acceptance:	10% of Contract Amount

The Bidder may offer a deduct in his proposal based upon a different payment schedule.

14.2 Requests for payment should be submitted in triplicate to the Purchaser's consulting engineer as designated below for review and approval. Contingent upon a favorable review, the engineer will forward invoices to the Purchaser within ten days for remittance of funds due. The Purchaser shall have 30 days after receipt from the engineer to forward payment.

Electrical Consulting Engineers
155 US Hwy 70 W.
Garner, North Carolina 27529
Attention: Tony B. Pearce, PE
tpearce@ecepower.com

14.3 Based upon the recommendations of the Engineer, the Purchaser reserves the right to deny payment where, in the opinion of the Engineer, materials and services delivered by the Seller do not meet the milestone requirements set forth in the Technical Specifications for workmanship, quality, or performance.

14.4 If a request for payment does not meet favorable review by the Engineer, the Engineer will provide written notice to the Seller identifying the perceived deficiencies responsible for rejection of the invoice. The Seller shall take immediate action in accordance with the "Remedying Faulty Work" section of these General Conditions to correct all deficiencies to the satisfaction of the Purchaser and the Engineer before resubmitting requests for payment.

15.0 Final Inspection, Affidavit, and Final Payment

15.1 After all materials and services have been incorporated into the Purchaser's project, tested in accordance with such field tests as specified, and apparently functioning as intended, the Engineer will make a final inspection of the Work. Based upon his findings, the Engineer will advise the Purchaser and the Seller whether or not the Work appears to be acceptable in accordance with the Contract Documents. If not so acceptable, the Engineer will identify the apparent defects in writing. The Seller shall take such measures as are necessary to remedy all defects in accordance with these General Conditions.

15.2 The Seller may submit a request for final payment after the following:

15.2.1 The Seller has successfully delivered all materials and provided all services in compliance with the Procurement Documents;

15.2.2 The Seller has delivered all maintenance and operating instructions, schedules, guarantees, certificates, and other documents required by the Contract Documents;

15.2.3 The Seller has furnished to the Engineer a signed, sworn, and notarized affidavit to certify that payment for all materials, services, and other activity in connection with the Contract has been satisfied and that no claims or liens exist against the Seller in connection with the performance of the Contract;

15.2.4 The Engineer has completed the final inspection of the Work; and

15.2.5 The Seller has remedied all apparent defects to the satisfaction of the Engineer and the Purchaser.

15.3 If, on the basis of the final inspection of the Seller's Work and review of the Seller's Affidavit, the Engineer is satisfied that the materials and services fulfill the technical and performance requirements of the Contract Documents, the Engineer will forward invoices to the Purchaser within ten days for remittance of funds due.

15.4 If the request for final payment does not meet favorable review by the Engineer, the Engineer will return the request for final payment to the Seller, identifying in writing the deficiencies which prevent recommendation of final payment. The Seller shall take immediate action in accordance with the "Remedying Faulty Work" section of these General Conditions to correct all deficiencies to the satisfaction of the Purchaser and the Engineer before resubmitting requests for payment.

15.5 The Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the materials and work provided by the Seller. In his capacity as interpreter and judge, the Engineer will not show partiality to the Purchaser or the Seller and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

15.6 Claims, disputes, and other matters relating to the Engineers judged acceptability of Seller's performance or the Engineer's interpretation of the requirements of the Contract Documents related to the Seller's performance and claims in respect to Contract Price or Contract Time will be referred initially to the Engineer in writing with a request for a formal decision in accordance with this paragraph, which the Engineer will render in writing within a reasonable time not to exceed 14 days. Written notice of each such claim, dispute or other matter shall be delivered by the claimant to the Engineer within 15 days after the occurrence or discovery of the event or condition giving rise thereto, and written supporting data will be submitted to the Engineer within 45 days after such occurrence or discovery unless the Engineer allows an additional period of time to ascertain more accurate data.

16.0 Taxes

16.1 The Seller shall pay all sales, consumer, use, and other similar taxes, required by law to be paid in respect of the production and delivery of the materials and furnishing of services.

16.2 Amounts payable by the Purchaser to the Seller for tax arising from the sale, purchase, or use of materials or services will be clearly and separately identified as tax on all invoices and will not be included in any sums in proposals or contractual agreements.

16.3 Requests for payment of sales taxes shall be accompanied by the Seller's notarized statement certifying the amount of sales taxes paid during the performance of the Contract Work.

17.0 Suspension, Cancellation, and Termination

17.1 Suspension by the Purchaser

The Purchaser may, at any time and without cause, suspend production of the materials or any portion thereof or the furnishing of work or other services for a period of not more than 90 days by notice in writing to the Seller and the Engineer. Upon fifteen days written notice from the Purchaser, the Seller shall resume performance. The Seller will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if the Seller makes an approved claim therefore as provided in the applicable sections of these General Conditions.

17.2 Termination by the Purchaser

The Purchaser may, after giving the Seller and the surety ten day's written notice and to the extent permitted by law, terminate the services of the Seller. In such case, the Seller shall not be entitled to receive any further payment until all materials are provided and all work furnished in accordance with the Contract Documents. If the unpaid balance of the Contract Price exceeds the direct, indirect and consequential costs to the Purchaser of such termination (including compensation for additional professional services), such excess will be paid to the Seller. If such costs exceed such unpaid balance, the Seller shall pay the difference to the Purchaser. Such costs incurred by the Purchaser will be approved as to reasonableness by the Engineer and incorporated in a Change Order, but when exercising any rights or remedies under this paragraph, the Purchaser shall not be required to obtain the lowest price. Where the Seller's services have been so terminated by the Purchaser, the transaction will not affect any rights and remedies of the Purchaser against the Seller then existing or which may thereafter accrue. Any retention or payment of moneys due the Seller by the Purchaser will not release the Seller from liability.

The Purchaser may terminate the Contract upon the occurrence of any one or more of the following events:

17.2.1 if the Seller commences a voluntary case under any chapter of the Bankruptcy code (Title 11, U.S. Code), as now or hereafter in effect, or if the Seller takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time relating to bankruptcy or insolvency;

17.2.2 if a petition is filed against the Seller under any chapter of said Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against the Seller under any other federal or state law in effect at the time relating to bankruptcy or insolvency;

17.2.3 if the Seller makes a general assignment for the benefit of creditors;

17.2.4 if a trustee, receiver, custodian or agent of the Seller is appointed under applicable law, or under contract, whose appointment or authority to take charge of property of the Seller is for the purpose of enforcing a lien against such property or for the purpose of general administration of such property for the benefit of the Seller's creditors;

17.2.5 if the Seller admits in writing an inability to pay its debts generally as they become due; or

17.2.6 a breach by the Seller in any substantial way of any provision of the Procurement Documents and such breach continues for a period of 15 days after written notice to correct the breach from the Purchaser to the Seller;

18.0 Equal Employment Opportunity Agreement

During the performance of the Contract Work, the Contractor agrees that:

18.1 The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, national origin, political affiliation or belief, age, or physical handicap. The Contractor will take affirmative action to insure that applicants are employed and that employees are treated during employment without regard to race, color, religion, sex, national origin, political affiliation or belief, age, or physical handicap. Such action shall include but not be limited to the following employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places available to employees and applicants for employment notices setting forth the provisions of the nondiscrimination clause.

18.2 The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, political affiliation or belief, age, or physical handicap.

18.3 The Contractor will send to each labor union or representative of workers, with which he has a collective notice to be provided, advising the labor union or worker's representative of the Contractor's commitments under the Equal Employment Opportunity Section of this Contract, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

18.4 In the event of the Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of such rules, regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further contracts with the Owner.

18.5 The Contractor will include the provisions of this section in every Subcontract unless exempted by rules, regulations, or orders of the Owner so that such provisions will be binding upon each Subcontractor.

19.0 Dispute Resolution

Disputes which cannot be resolved to the satisfaction of the contracted parties shall be resolved according to the applicable laws of the State of North Carolina.

20.0 Severability

The invalidity, illegality, or un-enforceability of any portion or provision of this Contract shall in no way affect the validity, legality and/or enforceability of any other portion or provision of this Contract. Any invalid, illegal or unenforceable provision of this Contract shall be deemed severed from this Contract, and the balance of the Contract shall be construed and enforced the same as if the Contract had not contained any portion or provision which was invalid, illegal or unenforceable. Provided, however, this section 20.0 shall not prevent this entire Contract from being void in the event any portion or provision of this Contract which is of the essence of this Contract shall be void.

CONTRACT

Town of Smithfield
SMITHFIELD, NORTH CAROLINA

In Accordance With
Procurement Documents
For A

OUTDOOR POWER TRANSFORMER

(BID SCHEDULE IS LOCATED IN THE BACK OF THE TECHNICAL SPECIFICATIONS AND MUST BE COMPLETED TO QUALIFY AS A RESPONSIBLE BID)

1.0 The undersigned (hereinafter called the "Bidder") hereby proposes to provide, sell, and deliver to the Town of Smithfield (hereinafter called the "Owner") the equipment, hardware, software, services and/or incidental items (hereinafter collectively known as the "Materials") identified in the Bid Schedules attached herewith for an OUTDOOR POWER TRANSFORMER in accordance with the terms and conditions described herein and in accordance with the following documents and instruments attached hereto and made a part thereof:

1.1 the Technical Specifications and Appendices, plans and drawings;
1.2 all Procurement Documents, including Notice to Bidders, Instructions to Bidders, General Conditions, Special Conditions, Proposal, Contract
1.3 the Bidder's Table of Exceptions and supporting literature; and
1.4 the Bidder's List of Deliverables;
1.5 the Bidder's Delivery Schedule; and
1.6 Any documented negotiations subsequent to the Owner's acceptance of the Proposal

2.0 The Bidder warrants that the materials and services will conform to the performance data and guarantees which are attached hereto and by this reference made a part thereof.

3.0 The Bidder warrants that this Proposal is made in good faith and that all bid prices have been derived independently and confidentially without collusion or connection with any other person or persons bidding for the same work as a separate Bidder identity or entity.

4.0 All prices quoted in the Bid Schedules shall be firm for a period not less than 60 days.

5.0 The prices quoted in the Bid Schedules do not include any amounts due for tax arising from the sale, purchase, or use of materials or services and that are payable by the Bidder.

6.0 If the Bidder is awarded a contract, amounts payable by the Owner to the Bidder for tax

arising from the sale, purchase, or use of materials or services will be clearly and separately identified as tax on all invoices and will not be included in any sums in any contractual agreements.

7.0 The prices quoted in the Bid Schedules include the cost of delivery of all materials and services to all sites designated in the Technical Specifications at the Bidder's risk.

8.0 Title to materials shall pass to the Owner upon delivery in accordance with the conditions designated in the Technical Specifications.

9.0 Delivery of materials and performance of services will be in accordance with the Project Schedule as proposed in the Bid Schedules and commencing subsequent to the date that a written Purchase Order or Acceptance notice is provided by the Owner to the Bidder.

10.0 At the discretion of the Owner, the Bidder, if awarded the order, will be allowed extensions for delivery of materials and performance of services for delays due to circumstances beyond the control of the Bidder and beyond the control of the parties under subcontract to the Bidder for materials and services. The Bidder will notify the Owner in writing upon detecting such circumstances and advise the Owner as to the nature and anticipated extent of the delay. The Owner will grant project schedule extensions to the Bidder, if, in the opinion of the Owner, the delays are beyond the control of the Bidder and his subcontractors.

11.0 The Bidder warrants the accuracy of all statements and exhibits contained herein and as may be attached herewith and furthermore agrees that the Owner shall rely upon such accuracy as a condition of the Contract in the event that this Proposal is accepted by the Owner.

12.0 The Bidder agrees that this Proposal, upon its acceptance by the Owner, will constitute a binding Contract between the two parties. Such Contract shall become effective upon acceptance of the Proposal by the Owner.

13.0 It is understood that by submitting a bid, the Bidder acknowledges that he has carefully examined the documents pertaining to the work, has understood same and is satisfied that he will, if successful, perform said work in accordance with the documents as well as any other rules, ordinances, codes, regulations, laws etc. pertaining thereto. The Bidder must explicitly note all exceptions, clarifications, and deviations from the requirements of this Contract (including General Conditions and all other Bid Documents). Each notation must be referenced to the specific sections and paragraphs in question. The Table of Exceptions must be presented with the proposal at the time of bid opening. Failure to identify an exception, clarification, or deviation will be considered certification that all products and services perform in full compliance with the Contract. **Blanket substitution of the Bidders standard terms and conditions or other documents will not be construed as constituting an exception.** The terms and conditions as stated in this Contract govern in event of conflict with any terms of Bidder's proposal, and are not subject to change by reason of any written or verbal statements by Bidder or by any terms stated in Bidder's proposal unless same be accepted in writing by the Owner.

PROPOSAL SIGNATURE PAGE

Bidder does hereby covenant and agree with the Owner that Bidder will faithfully furnish the materials as above set out in accordance with each and every one of the conditions, covenants, stipulations, terms, and provisions contained in the specifications at the prices and rates respectively named thereof in the proposal attached hereto, and will faithfully comply with each and every obligation imposed upon Bidder by said specifications or the terms of said award.

Refer to the Instruction to Bidders for proper signing procedure.

Respectfully submitted this _____ day of _____, 20____

_____
Name of Firm

By: _____

_____

_____
Title

Witness:

_____
(Proprietorship or Partnership)

Attest:

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

OWNER'S ACCEPTANCE

The Owner hereby accepts the foregoing Proposal by the Bidder _____ and hereby agrees to enter a Contract on this _____day of _____ 20__ with the Bidder for purchase of OUTDOOR POWER TRANSFORMER(S) for a total Contract Price of _____

As a supplement to the contract, the Owner will issue a standard Purchase Order with a basic description of the purchase and a reference to this Contract. This Contract, together with the Purchase Order, shall signify the Owner's acceptance of the Bidders Proposal, including any explicitly-named negotiations, clarifications and amendments established during the bid evaluation period and shall constitute a binding Contract between the Owner and the Bidder predicated upon such conditions.

Town of Smithfield
Smithfield, North Carolina

*By:*_____
Title: _____

WITNESS:

_____

This instrument has been preaudited in the manner required by the Local Government Budget and Fiscal Control Act.

_____
(Signature of Finance Officer)

Certificate(s) of Insurance

Town of Smithfield
Smithfield, North Carolina

Technical Specifications
For
Three-Phase Outdoor Oil Filled Power Transformer

1.0 Scope

1.1 General

This specification covers the design, construction, delivery, and assembly requirements for a two winding liquid immersed three-phase outdoor power transformer to be installed in a substation being constructed by the Town of Smithfield (Smithfield, Town, Owner, Purchaser). Specific rating information pertaining to this unit is provided in the ratings schedule in Appendix A. Owner intends to purchase two units based upon this specification.

1.2 It is the intent of these specifications to procure a transformer that is complete and fully functional (ready for energization) for the price stated in the proposal. Any services not specifically mentioned herein but required for a fully functional unit shall be supplied.

1.3 Standards

The transformer shall be designed, manufactured and tested in accordance with the latest edition of applicable ANSI/IEEE ASTM, and NEMA standards. In the event of conflict between standards, ANSI/IEEE shall take precedence over all other standards.

1.4 Where reference is made in these specifications to "ANSI/IEEE C57", compliance is required to the latest edition of all applicable standards contained within IEEE Standards Collection C57 *Distribution, Power, and Regulating Transformers* which contains numerous discrete standards bearing the prefix designation "ANSI C57" or "IEEE C57", plus IEEE 62, IEEE 259, IEEE 1276 and IEEE 1388.

1.5 All components of the transformer shall be new.

2.0 Drawings & Documentation

2.1 Proposal Documentation

2.1.1 Outline drawing with a list of all major materials to be provided.

2.1.2 Performance data and evidence of short circuit tests for similar designs.

2.1.3 Manner in which unit is to be shipped (truck, rail, oil filled, air-filled, nitrogen filled, bushings installed).

2.1.4 Final proposal price for manufacture, delivery, field assembly, field testing etc., shall be listed as one single price on the bid schedule sheet in the contract documents. Separate prices for various services can be included in the supporting documentation but the Owner will not be responsible for searching through such documentation to determine the total price.

2.1.5 If Unit is to be manufactured outside of the continental US, Mexico or Canada, bidder must provide a list of US utilities that have received units with current contact information.

2.1.6 Bidder must provide name of actual manufacturer; representative information is not sufficient.

2.2 Submittal Information for Review & Approval

Prior to commencing production of the transformer, the manufacturer shall submit to the Purchaser's Engineer drawings and information for review of conformance to technical specifications.

2.2.1 Bidder shall indicate in his supporting documents the schedule for which drawings will be submitted. All documents submitted shall be clearly identified as "PRELIMINARY" and "SUBMITTED FOR APPROVAL."

2.2.2 Documents shall also clearly identify the name of the end use customer, the name of the project, and the Purchaser's Contract or Purchase Order Reference Number. All drawings transmitted shall clearly identify the manufacturer's Shop Order Reference Number.

2.2.3 The manufacturer shall submit the approval drawings and documentation to the Purchaser's Engineer via e-mail in .pdf format. All drawings shall also be submitted in .dwg format. Based upon comments by the Engineer, manufacturer shall make corrections if necessary, and resubmit within 30 calendar days. The Engineer reserves the right to require the manufacturer to resubmit approval documentation for additional review after corrections.

2.2.4 Approval of documentation by the Purchaser or Purchaser's Engineer shall not relieve the manufacturer of the responsibility for meeting all requirements of the specifications, for correctness of the drawings and the proper design of the equipment.

2.2.5 Drawings and information thereon submitted for approval shall include the following:

2.2.5.1 Transformer outline drawing showing overall dimensions and weight including all accessories and conduits. Drawings shall include center of gravity, shipping dimensions, assembly dimensions, and weights. Drawings shall be scaled in concurrence with the noted dimensions.

2.2.5.2 Bill of material itemizing quantity, manufacturer, model, catalog #, rating and operating characteristics of each component and accessory.

2.2.5.3 Item lists, device legends, etc. on drawings shall have the original manufacturer's name and catalog number listed. The transformer manufacturer's in-house part # only is not acceptable.

2.2.5.4 Nameplate information, identifying the characteristics and capacities of the transformer in compliance with ANSI C.57.12.00-2000, Table 10-Nameplate C.

2.2.5.5 "Cut sheet" details providing schematic and physical representation of all coils, relays and control devices used for control and annunciation. Such details may be integrated into manufacturer's drawings or supplied as supplemental drawings. Nameplate information for each device shall be provided. "Cutsheet" shall include complete operational instructions for any devices with selectable or adjustable parameters.

2.2.5.6 Control cabinet physical drawings showing interior section views with devices identified. Drawings shall be accurate to actual physical arrangement and scaled to concur with dimensions.

2.2.5.7 LTC physical, electrical and auxiliary schematics if LTC is specified

2.2.5.8 Bushing outline with manufacturer and terminal information.

2.2.5.9 CT drawings and curves including secondary excitation characteristic and ratio correction factor curves. Secondary excitation characteristic curve shall show the current transformer thermal factor and secondary winding and lead resistances.

2.2.5.10 Schematic elementary diagrams and physical wiring interconnection diagrams for all relay, control and auxiliary service circuitry.

2.2.5.11 Complete information regarding the truck configuration required to transport the unit including axle weight, number of axles and turning

radius.

2.3 Final Documentation

2.3.1 The manufacturer shall furnish four (4) sets of final drawings not later than ten (10) working days following shipment of the transformer. At least two (2) sets of these drawings shall be "D" size or larger. One additional set of drawings shall be shipped with the transformer.

2.3.2 Four (4) instruction books shall be included with the final drawings. The instruction books shall cover complete installation, operating and maintenance instructions, drawings and parts lists, cut sheets, etc for each item of equipment furnished. The instruction book shall have a list of recommended spare parts. One additional complete instruction book set shall be shipped with the transformer.

2.3.3 Two copies of the complete test report shall be furnished with final documentation.

2.3.4 Each instruction book shall have a Compact Disk or USB flash drive containing all literature, drawings and photographs. Digital information should also be e-mailed. Drawings shall be in .dwg and .pdf format. Literature shall be in .pdf format. Literature should include but not be limited to all test results, instruction manuals, photographs, welding records, and other documentation required by this specification.

2.3.5 The manufacturer shall furnish two (2) complete sets of photographs of the core and coil assembly of the transformer. Prints are to be 8-1/2" x 11" color. Top, side (all four) and LTC (if specified) views shall be depicted and labeled appropriately.

2.4 Use of Documentation

The manufacturer shall grant the Purchaser the right to use or to furnish to other vendors, for subsequent work, the drawings made by manufacturer, including design drawings, shop detail drawings, erection drawings and bills of material.

3.0 Delivery

3.1 Shipment, unless otherwise agreed upon, shall be made F.O.B. transformer foundation slab at the Purchaser's designated project site. All aspects of transportation to the foundation slab shall be the responsibility of the manufacturer or his selling agent, including inspection, unloading, rigging, and installation onto the foundation. Seller is responsible for investigating the site to identify any potential delivery issues. Site address is in Appendix A.

3.2 Seller shall provide all labor and equipment to install oil, install accessories, provide testing, and all other necessary functions as required to provide a fully functional unit ready for energization. Seller shall provide a written certification that unit is ready for energization.

3.3 The transformer shall be shipped upright and as complete as possible in accordance with transportation limitations and protection of the equipment.

3.4 Transformer accessories shall arrive with the transformer.

3.5 Prior to shipment, the transformer shall be filled with moisture-free media and sealed against intrusion of free atmosphere. The manufacturer may elect to ship transformers oil-filled as transportation and unloading issues dictate.

3.5.1 If the transformer is shipped oil filled, additional insulating oil shall be shipped with the transformer as needed to fill the transformer to normal operating level after the transformer has been outfitted in the field with radiators, coolers, and all accessories that may affect final oil volume of the transformer. Bill of lading and associated documentation shall note volume of oil contained within transformer at time of shipment and temporary signage shall be attached to the main tank to advise that the transformer is oil filled.

3.5.2 Use of "dry air" may be used to fill all free space within the transformer interior. Alternately, nitrogen gas (N_2) may be used for this purpose.

3.5.3 When nitrogen gas (N_2) is used to fill interior free space, temporary signage denoting breathing hazards shall be affixed near the manholes. Such warning signs shall advise appropriate purging precautions to be taken. Mounting method for the advisory sign shall allow the Purchaser to remove the sign after field installation has been completed without compromising the integrity of the transformer finish.

3.6 The manufacturer shall furnish three-direction digital impact recorders attached to the transformer as near as possible to the transformer base. The impact recorders shall be installed while the transformer is on the production floor and shall not be removed until the transformer is placed on the foundation slab. The recorders shall document date and time of severe impacts. Impact recorder information shall be read (downloaded) by the manufacturer's representative at the site. A copy of impact recorder readings shall be furnished to the Owner at the site after placement of the transformer on the pad. The manufacturer's representative shall provide and explain the information to the Owner or the Owner's representative at the jobsite. All readings shall be returned to the factory for warranty validation.

3.7 The manufacturer shall provide a factory-qualified agent at the destination prior to and during unloading to inspect the condition of the transformer and accessories as

received. The Inspector's duties shall include the following responsibilities.

3.7.1 Inspection of impact recorder data.

3.7.2 External inspection of transformer and accessories noting evidence of damage in transit. Inspection should include signs shifting such as damaged blocks, supports, etc. Any signs of damage shall delay final unloading of transformer until authorized by the Manufacturer.

3.7.3 Confirm that unit has positive or negative [not zero] pressure in gas space. If unit has zero gas pressure, manufacturer shall perform field test to find and quantify any leaks. Manufacturer's field service shall measure moisture content of internal gas and immediately provide results and test procedures to Purchaser.

3.7.4 Filing of any claims against transportation agents.

3.7.5 On-site coordination of work with subcontractors for unloading, transport, and installation to foundation.

3.7.6 Administration of manufacturer's paperwork.

3.7.7 Provide a signed copy of manufacturer's checklist for transformer delivery, installation testing, etc.

3.7.8 The Inspector (or another authorized Agent of the Manufacturer) shall perform or shall witness the tests as specified in the "Installation" article of these specifications and any other tests as required by the Manufacturer for warranty validation. This Inspector or Agent shall not be an employee of the entity contracted for moving and/or installation of the transformer.

3.8 The manufacturer shall include two (2) copies of the complete shipping list with transformer delivery.

3.9 The manufacturer shall provide the Purchaser 14 calendar days advance notice as to the date of shipment and anticipated transportation schedule. Confirmation of final schedule shall be provided 48 hours prior to shipment. Schedule and location of unit shall be updated daily while in transit.

4.0 Ratings

4.1 The transformers shall be designed and built with full rating capability for step-down voltage operation.

4.2 Operating voltage, MVA rating, BIL rating, and other specific information for the transformer shall be as provided in the ratings schedule. Refer to Appendix A for the specific ratings required for each transformer.

4.3 The transformer shall be capable of operating at the rated loads continuously at 5% above rated secondary voltage.

4.4 The transformer kVA ratings shall be as shown in the ratings schedule for 65ºC average or 80ºC hottest spot temperature rise based on continuous load.

5.0 Main Tank

All physical aspects of the transformer tank and accessories mounted thereon shall be designed in accordance with ANSI/IEEE C57.12.10 and shall facilitate transportation, inspection, installation and handling in accordance with guidelines prescribed by ANSI/IEEE C57.93-2019.

5.1 General Construction

5.1.1 Unless specified otherwise, the transformer shall feature top-mounted bushings for all external winding terminals. Location of accessories shall be in accordance with ANSI/IEEE C57.12.10 Figure 1. Arrangement of bushings and assignment of winding leads thereto shall be in accordance with ANSI/IEEE C57.12.10 Figure 2.

5.1.2 The main tank shall provide two ground pads for bonding the tank case to a substation ground grid. Grounding pads shall be sized and located at diagonally opposite corners of the tank near the base in accordance with ANSI/IEEE C57.12.10. Grounding pads shall be stainless steel.

5.1.3 The tank shall be designed and braced for full vacuum and for positive pressure of 8 psig with allowances for 25% over pressure.

5.1.4 The tank base shall be of heavy plate sufficiently strong to permit skidding or rolling the unit parallel to either tank centerline. The base shall incorporate I-beams or similar features to allow air circulation beneath the tank.

5.1.5 The tank shall be designed for full vacuum filling in the field.

5.1.6 Steel for tank walls shall be formed so that all seams are mated along flat surfaces. Seam welds within 6 inches of any corner of the tanks walls will not be accepted.

5.1.7 Arrangement of transformer and accessories shall not restrict gas from reaching

gas detector relay where such detection relay or provisions therefore are furnished.

5.2 Welds

5.2.1 The tank seams and penetration bosses shall all be double welded (inside and outside).

5.2.2 Welding shall comply with the latest codes of the American Welding Society. Welding shop practices and associated fabrication procedures shall observe the guidelines prescribed by Chapter 17, 'Safe Practices' of the *Welding Handbook*, 10th Edition, Vol. 1 and as set forth by ANSI / ASC Z49.1, *Safety in Welding, Cutting, and Allied Processes*.

5.2.3 Welding shall be performed only by operators qualified by tests prescribed by the American Welding Society AWS D1.1-2020 *Structural Steel Code*.

5.2.4 Records of welding procedure and welding operator test results shall be kept for five (5) years by the manufacturer and shall be available for review by the Purchaser.

5.2.5 Field welding will not be accepted.

5.3 Cover and Manholes

5.3.1 Cover shall be welded to tank and be designed to shed water. An inorganic gasket shall be permanently located between the cover and tank to prevent the entrance of foreign matter during welding or subsequent removal of welds.

5.3.2 The tank cover shall be equipped with a minimum of four (4) lifting eyes appropriately positioned and sized for removal of the tank cover by overhead rigging slings.

5.3.3 The tank cover shall provide a minimum of two round manholes each not less than 18 inches in diameter. Manholes shall be larger if required to permit removal and installation of the bushing current transformers.

5.3.4 The manufacturer shall provide fall protection in accordance with the following:

5.3.4.1 The tank cover shall include provisions near the center of the cover for mounting one fall prevention tether pole or similar device meeting OSHA 1926.104 rating of 5400 pounds. Studs welded to tank cover are not an acceptable mounting method. The manufacturer shall furnish one (1) tether pole and mounting base with each transformer.

5.4 Lifting and Jacking Facilities

5.4.1 The main tank shall be provided with a lifting brace at each upper corner of the tank. Braces shall be designed for a safety factor of 5.0 (minimum) as designated in IEEE C57 for lifting the entire transformer unit including oil. Bearing surfaces of lifting facilities shall be free of sharp edges and burrs.

5.4.2 The tank shall be furnished with pulling eyes and rounded or sloped base per ANSI / IEEE Standard C57. Base shall be of heavy plate sufficiently strong to permit skidding or rolling the unit parallel to either tank centerline.

5.4.3 The main tank shall be provided with jacking facilities located at lower corners of the main tank. Jacking facilities shall be designed for support of the entire transformer including oil with a safety factor of 5.0 as required in IEEE C57. Location and dimensions of jacking facilities shall observe guidelines illustrated in Figure 3 of C57.12.10.

5.4.4 Pulling provisions shall be provided as described in Section 5.3.3 of IEEE C57.12.10.

5.4.5 Each manhole cover, radiator and / or cooler shall be supplied with lifting eyes. These lifting eyes shall be designed to also provide suitable anchor points for attachment of personnel fall protection equipment.

5.5 Valves

5.5.1 Drain sampling and upper & lower (with 3/8" oil sampling device) filter press connection valves shall be provided per ANSI / IEEE C57. Valves shall be non-rising stem bronze gate valves. All valves shall be able to be removed without disassembly of the valve. Valves shall be flange mounted.

5.5.2 A 2" globe valve shall be provided and positioned at approximately 5'-6' above the base of the unit for possible future installation of a gas-in-oil monitor similar to a Vaisala, Optimus DGA Monitor.

5.6 Mechanical Pressure Relief Device

5.6.1 The transformer main tank shall feature a mechanical pressure relief device (PRD) to automatically vent excessive internal pressure. The pressure relief device shall be Qualitrol "Extra Protection" style XPRD. Directional venting system shall be provided to limit and control the discharge of hot oil to ground. See Section 17.5 for additional details.

5.6.2 The manufacturer shall ensure that sufficient mechanical pressure relief devices are installed to prevent rupture at tank welds or manholes.

5.6.3 If the transformer has been specified to include an OLTC, the OLTC compartment shall be equipped with a separate mechanical pressure relief device of equal design as noted above (directional venting not required).

5.7 Rapid Pressure Rise Relay (RPRR)

5.7.1 The manufacturer shall provide and install a Rapid Pressure Rise Relay to detect high rate of rise in transformer pressure and automatically initiate removal of the transformer from service via auxiliary protective relay systems associated with the transformer.

5.7.1.1 Relay operation shall employ a mechanically operated diaphragm, physically tuned for response to rapid rates of rise in transformer pressure. Mechanical operation of the diaphragm shall be automatic, self-resetting, and repetitive for each occurrence of sudden pressure rise.

5.7.1.2 In each instance of operation, the diaphragm shall initiate a set of Form C electrical contacts. Momentary operation of the contacts from their normal state shall be suitable for initiation of the operation of downstream protective relays and circuit interrupting devices to clear the transformer from service. The electrical contacts of the relay shall be self-resetting when the RPRR mechanical diaphragm restores to normal position.

5.7.1.3 The relay assembly shall include weatherproof electrical cables and connectors to route wiring from the electrical switch assembly to the transformer control cabinet.

5.7.2 The manufacturer shall determine a mounting location for this relay on the tank that will provide adequate protection against false operation that might be caused by normal pressure variations and associated coolant flow.

5.7.3 To the extent practical, the relay shall be mounted to allow personnel to access the relay for tests and maintenance while the transformer is energized.

5.7.4 If the transformer has been specified to include an OLTC, the OLTC compartment shall be equipped with a separate RPRR.

5.7.5 See Section 17.4 for additional details.

5.8 Gaskets

5.8.1 Gasket joints for bolted attachments subject to removal shall be designed as to minimize gasket damage.

5.8.2 Gasket surfaces shall be provided with properly sized and machined grooves for gasket compression stop limits.

5.8.3 All gaskets are to be one piece design, without splices and shall be Nitrile or Buna-N material suitable for reuse. Cork or Corkprene gasketing materials are unacceptable gasketing materials for this application.

5.8.4 Gasket material shall have durometer reading of 65 +/- 5 hardness.

5.8.5 Gaskets shall be 1.33 times height of groove and 0.75 times the width of groove. For O-rings use the nearest nominal O-ring that fits these parameters. Flat gaskets shall have a width at least 1.5 times the height. When compressed the groove must be filled to 95% minimum and be leak free.

5.8.6 Gasket compression shall be between 20 and 40 percent.

6.0 Core and Coil

6.1 General Construction

6.1.1 Core and coil design shall be cylindrical. Rectangular core and coil designs will not be accepted.

6.1.2 The core and coil assembly shall be adequately braced to withstand bolted faults with fault current limited only by the impedance of the transformer.

6.1.3 For core form transformers, the degree of inner winding buckling shall be calculated for “free” or unsupported buckling and for “forced” or supported buckling.

6.1.3.1 The manufacturer shall identify in his proposal the criteria employed by its design staff to determine what is an acceptable degree of buckling stress without transformer damage.

6.1.3.2 The manufacturer shall demonstrate that calculated stresses for free and forced buckling for this specific project are within the judgment criteria used.

6.1.3.3 The percent change in transformer impedance as a result of buckling stresses shall be no greater than the percent change in voltage over the entire tap range.

6.1.4 All clamping rings shall be one-piece continuous non-metallic material.

6.1.5 The core and coil assembly shall be provided with facilities for lifting the complete assembly from the tank.

6.1.6 The transformer core shall provide a removable core ground conductor to bond the core steel to the transformer main tank. Core ground strap and connections shall have minimum ampacity equivalent to 4/0 AWG copper. Core ground strap connection to tank shall be external.

6.1.7 The Purchaser shall be given the opportunity to inspect core and coil assembly during production. Notification of assembly shall be given at least two (2) weeks in advance.

6.2 Coils

6.2.1 All winding conductors shall be copper.

6.2.2 Unless specified otherwise in the ratings schedule in the Appendix, all three-phase transformers shall be connected for subtractive polarity in accordance with ANSI/IEEE C57.12.10, Article 5.6.

6.2.3 Angular displacement for Δ-Δ or Y-Y winding configurations shall be 0 degrees.

6.2.4 Angular displacement for Δ-Y or Y-Δ winding configurations shall be 30 degrees, low-voltage winding lagging the corresponding high-voltage winding.

6.2.5 Connection of windings and assignment of winding terminal leads shall be in accordance with ANSI/IEEE C57.12.10, Figure 2 and Figure 4.

6.2.6 Unless specified otherwise by the ratings schedule in the Appendix, the neutral of all Y-connected windings shall be insulated from the transformer core at full BIL rating and shall be brought out to an external bushing (e.g XO) of full BIL rating for the applicable winding.

6.2.7 Coils shall be hydraulically sized to design stress level.

6.2.8 All coil leads shall be firmly supported by routing through insulating tubing. Support by taping to barriers is not acceptable.

6.3 Core

6.3.1 Core shall be constructed of high permeable, grain oriented, laminated silicon steel. Laminations shall be flat and without burrs. Core laminations shall be finished with an epoxy coating impervious to transformer oil at the maximum

design temperature.

6.3.2 Use of core bolts is not acceptable.

6.3.3 Epoxy binders on core top yoke are not acceptable.

6.3.4 Core-to-end-frame insulation shall be solid high density material.

6.3.5 Mounting studs for attachments to any part of core or coil assembly shall be fully welded.

6.4 Insulation

6.4.1 A thermally upgraded insulation system shall be furnished to provide for operation at the 65ºC nameplate rating. Conductors shall be insulated with WEIDMANN 12HCCor 22HCC crepe paper or WEIDMANN M-250 flat paper thermally stabilized using the INSULDUR ™ system.

6.4.2 Barriers and spacers must be made from high density (1.5 gm/cc minimum) recompressed pressboard. The only exception is formed parts that must be made from formable grades having minimum densities of .95 gm/cc. Pressboard components shall be manufactured from WEIDMANN and/or ABB Pucaro Transformerboard. Corrugated material is not allowed.

7.0 Oil and Oil Preservation Equipment

7.1 Insulating Oil

7.1.1 The transformer insulating oil shall be furnished by the transformer manufacturer.

7.1.2 Transformer insulating oil shall be entirely new product and shall not result from recycling or salvaging old product. The transformer oil supplied shall not be manufactured by blending recycled or salvaged product with new product.

7.1.3 The insulating liquid shall be mineral oil meeting the requirements of ASTM D3487. Electrical insulating properties and reactive chemical properties of the oil shall meet ANSI and IEEE standards for the intended application and shall be tested for compliance to such standards by ASTM methodology. Characteristics of the oil shall comply with the values for all test parameters identified by Table 3 of IEEE C57.106 when tested by the ASTM methods noted therein.

7.1.4 Inhibition of the insulating oil is not required but is acceptable. Proposal shall

include information on oil to be furnished with transformer.

7.1.5 The insulating oil shall be certified as non-PCB in compliance with the current applicable regulations of the Federal Register. Non-PCB certification of the original fill and fill date shall be labeled on the transformer tank, either on the main nameplate or a supplemental permanent method.

7.2 Oil Preservation System

The oil preservation system shall be either a passive sealed tank or an automatic inert-gas system as specified in the rating schedule.

7.2.1 Passive Sealed-Tank Liquid Preservation System

The interior volume of the transformer shall be sealed from ambient atmosphere through all top liquid temperatures up to 100° Celsius.

- The sealed system shall be designed to self-maintain an internal gas pressure between the limits of 10 psi gage positive and 8 psi gage negative when the transformer is oil filled per ANSI/IEEE C57.12.10.

- The sealed system shall include an automatic pressure-vacuum bleeder device with operating characteristics coordinated with the allowable limits of the internal gas pressure. Operating values of pressure and vacuum may be different than the limits above for a particular transformer. Bleeder device operating parameters shall be indicated on the nameplate.

- The bleeder hardware shall include a pressure-vacuum gauge equivalent to Qualitrol Model 070-35C with 0 atmosphere indicating at the null position. The bi-directional range of the gauge shall be capable of displaying pressure and vacuum levels in excess of the allowable transformer limits. The gauge shall be mounted on the exterior wall at eye level from base elevation and shall include all plumbing necessary to accomplish this location.

- Where gas expansion piping is installed on the tank exterior, such piping shall be steel with welded joints or stainless steel tubing with Deutsch compression connections.

7.2.2 Automatic Inert-Gas Oil Preservation System

The interior of the transformer shall be sealed from ambient atmosphere over all top liquid temperatures up to 100° Celsius and positive pressure shall be continuously applied by a supplemental supply of nitrogen gas.

- The inert-gas system shall provide a full cylinder of nitrogen gas housed in

a weatherproof enclosure separate from all other control cabinets. The enclosure for the gas system shall be mounted onto one wall of the transformer main tank. The enclosure shall be equipped with a method of securing the nitrogen cylinder vertically in place and restrain the cylinder from tipping or falling when the enclosure is open for inspection.

- The characteristics of the nitrogen gas employed by the inert-gas system shall comply with ASTM D1933, Type III.
- The containment cylinder for the nitrogen gas shall be equivalent to Air Liquide 44, Airco 200, or Air Products B. The cylinder shall be connected to the system with flexible high pressure hoses with No. 580 (CGA) connections per ANSI/ICGA-V-I-1987. Filling pressure shall be rated for 2200 lbf/in^2 at 70° Fahrenheit.

- The inert-gas system shall be plumbed with all regulating devices necessary to automatically and continuously maintain a positive pressure not less than 0.5 PSI and not greater than 8 psi gage (5 PSI typical for relief valve operation) on the interior volume of the transformer. Gauges used for display of the regulated pressure shall be scaled such that the pressure at lower levels is clearly indicated.

- The inert-gas system shall be designed with shut-off valves installed at all locations as necessary to isolate and exchange nitrogen cylinders while the transformer remains in service under sealed volume.

- The inert-gas system shall provide pressure-vacuum gauges at all locations on the system as necessary to locally display the status of the system pressure with nitrogen cylinder in service and with nitrogen cylinder removed from service. Gauges shall be equivalent to Qualitrol Type 050-010-01 and CGA-approved. (Note that a separate gauge is required which is directly mounted to the transformer tank and displays the tank pressure)

- The inert-gas system shall provide Form C alarm contacts on the gas regulating equipment to remotely alarm the following conditions. Leads from all contacts shall be wired to user-accessible terminal blocks in the main transformer control compartment.

    1. Low nitrogen cylinder pressure
    2. Low system gas pressure (regulated)
    3. High system gas pressure (regulated)

- The manufacturer shall provide and install all plumbing, valves, gauges, regulators, alarms, wiring, enclosures, and cylinder hardware prior to shipment. The nitrogen cylinder may be shipped installed, shipped as a

detached accessory, or provided upon transformer delivery by a local supplier under contract to the manufacturer.

- Any on-site assembly of the inert-gas system after delivery shall be the responsibility of the manufacturer.

- Low pressure lines from the system control cabinet to the transformer gas space shall be of the type recommended by the inert-gas system manufacturer. Lines shall be installed and secured to the transformer tank in a manner to prevent fracture or other damage from vibration. Low pressure and high pressure hoses provided as part of the inert-gas control system shall be constructed of flexible braided stainless steel (other hose types may be accepted if approved by the Owner) with connections as defined by the Compressed Gas Association. The system shall incorporate check valves as necessary to prevent gas from escaping from the transformer gas space.

8.0 On Load Tap Changer (OLTC) for Transformer Secondary

8.1 The transformer shall provide a Reinhausen MR Type RMV-II-2000 LTC for regulating the output voltage of the transformer secondary windings.

8.2 The LTC and all tests applied thereto shall conform to the latest standards of the IEEE, ANSI, NEMA, and NESC.

8.3 LTC shall regulate voltage at 10 percent above and below rated voltage in 16 5/8% steps. For voltage regulation ranging between nominal and ten percent below (lower tap positions), the LTC shall have capacity for secondary load current corresponding to rated transformer kVA and the selected voltage tap position. For voltages above rated position the transformer shall deliver rated KVA.

8.4 The LTC shall be designed to withstand full-voltage short-circuit conditions, and complete automatic operation of any tap change under such conditions without failure of the tap-changer mechanism or tap-changer windings. The oil-filled tap-changer compartment shall be outfitted with an RTD oil temperature sensor for input into the SEL 2414 monitor device.

8.5 The secondary windings of the transformer shall be tapped as necessary to provide the desired number of tap steps and percent voltage regulation. A series transformer may be incorporated into the design of the main core and coil assembly, if necessary, to achieve the appropriate regulation.

8.6 LTC oil filled compartment shall have independent pressure relief device,

sudden pressure relay, sudden pressure seal in relay, and liquid level gauge as described herein for the main tank. Pressure relief device down tube for LTC is not required. Oil filled compartment shall also have drain valve and breather.

8.7 The air compartment housing the motor drive assembly (different from LTC control as listed in 8.8) shall provide control equipment as typically furnished for LTC control with the following features and accessories:

a. Electrical transfer switch to block automatic control of the drive motor and provide electrical raise and lower control of the drive motor locally at the motor control compartment.
b. Position indicator with drag hands and limit switches.
c. Neutral indicator light
d. Operation Counter
e. Potential circuit breaker
f. Output test terminals
g. Provision for manual operation with auto-manual switch with raise and lower
h. Provisions for bottom conduit entry
i. Moter power supply switch and breaker
j. 120 Volts AC thermostatically controlled low wattage strip heater, complete with overcurrent circuit breaker, for protection against condensation within compartment.
k. 120 Volts AC compartment lamp with plunger switch activated by compartment door and protected by overcurrent circuit breaker.
l. All wiring necessary for interconnection between the components of the motor control compartment and the automatic voltage control equipment shall be provided by the Manufacturer.

8.8 LTC Automatic Control

8.8.1 The transformer shall provide microprocessor-based automatic control of the LTC for load-compensated voltage regulation. The automatic LTC controller shall be a Beckwith Model M-2001D Digital Tap-changer Control as manufactured by Beckwith Electric Company, Inc. part number M-2001D-6L4S2BF0S00.

8.8.2 LTC backup control module M-0329B shall be provided.

8.8.3 The LTC controller shall provide DNP 3.0 communications via fiber optic port.

8.8.4 The Beckwith 2001D tap-changer control shall be mounted in the main control cabinet of the transformer using a Beckwith M-2270B

adapter panel.

8.8.5 To accommodate bus voltage regulation in parallel with a 2nd LTC transformer, a parallel current balancing control module shall be provided in conjunction with the Beckwith 2001D. The parallel balancing module shall be a Beckwith Model M-0115A control. Beckwith M-0127 AC Current Relay shall be provided and implemented to protect from damaging circulating currents during parallel operation.

8.8.6 To accommodate digital access to the digital tap-changer control memory, one copy of the latest version of Beckwith M-2029 "TapTalk" communications software shall be provided.

8.8.7 Copies of Beckwith literature detailing the features of each device shall be included in the final drawings.

8.8.8 The transformer shall provide a current transformer for line-drop compensation measurement by the tap-changer control. The current transformer ratio shall be as determined by the manufacturer but system shall with a 5:0.2 ratio auxiliary transformer M-0169A for input to the control.

8.8.9 An Owner supplied externally mounted potential transformer having a line to neutral voltage ratio of 60:1 will supply sensing voltage input to the tap-changer control will be provided. (For future operation at the higher low side voltage, the Owner will supply a 110:1 PT)

8.8.10 The Manufacturer shall provide all interconnection wiring between the control modules, current transformers, auxiliary equipment, and field termination blocks to achieve a completely functional automatic voltage regulating system. Terminations shall include all interconnections between the available I/O functions of the digital tap-changer control and field termination blocks. These functions include, but are not limited to, the following:

- External sensing voltage input
- Paralleling connections to 2nd transformer
- Self-test alarm contact outputs
- Multi-step voltage reduction input
- Drag Hands Reset
- Neutral Indication
- Tap Position

8.8.11 Tap changer controls can be installed in the main control cabinet as described herein or in separate cabinet as determined by the manufacturer.

9.0 De-Energized Tap Changers

9.1 High Voltage De-Energized Tap Changer

9.2.1 The transformer high voltage winding shall be rated at the nominal system voltage with five full capacity taps (two above and two below nominal voltage) as indicated in the ratings schedule.

9.2.2 An operating handle shall be provided for external operation of the tap changer with the transformer de-energized. It shall be brought out through the transformer tank per IEEE Standard C57, but not over six feet above the base of the transformer. Provisions shall be made for padlocking the handle in any tap position. DETC tap position shall be visible from ground elevation.

9.2.3 The tap changer shall be designed so that it will not have to be moved to wipe the contacts to prevent coking in less than 10 years. No tap changer will be accepted that does not meet this requirement.

9.2.4 The tap position indicator shall use the letter A,B,C,D, and E for indication of the tap positions. "A" position shall be the highest voltage tap.

9.2.5 A warning label shall be placed near the tap changer handle that reads

115 KV TAP CHANGER

DANGER

DO NOT OPERATE TAP CHANGER
WITH TRANSFORMER ENERGIZED.

9.2 Low Voltage De-Energized Tap Changer (Dual Voltage Tap Changer)

9.2.1 The transformer shall be designed with a dual voltage secondary winding producing nominal voltages as shown in the ratings schedule.

9.2.2 Any dual voltage transformers shall be of the constant flux design.

9.2.3 The transformer secondary winding assembly shall include a tap changer link

board allow the secondary winding voltage to be changed under de-energized conditions.

9.2.4 The tap changer link board shall be located below the minimum oil level in the main tank and shall be accessible through one or more of the top mounted manhole covers.

9.2.5 The tap changer link board shall provide all taps, cables, conductor bars, connectors and related materials necessary to perform a de-energized reconfiguration from either secondary voltage rating to the other voltage in the field.

9.2.6 The tap changer link board assembly shall provide insulation qualities and BIL rating in accordance with the design stresses associated with the highest secondary winding voltage.

9.2.7 All tap positions relevant to Voltage Rating 1 and Voltage Rating 2 shall be clearly and permanently identified on the tap changer link-board assembly with a method impervious to the oil medium.

9.2.8 Transformer shall be left on the 12.47/7.2 kV tap.

10.0 Radiators and Auxiliary Cooling Equipment

10.1 Radiators

10.1.1 Radiators shall be designed for weatherproof operation and to prevent water collection on external top surfaces.

10.1.2 Radiators shall be designed to promote free flow of oil by natural convection.

10.1.3 Radiators shall be designed to facilitate on-site painting and similar preventive maintenance activity.

10.1.4 Transformer shall be designed for radiators to mount independently of one another and allow removal without need to remove another radiator.

10.1.5 The top and bottom port between each radiator and the transformer main tank shall be equipped with isolating valves on the main tank, allowing removal of any radiator without draining oil from the main tank. Valves shall be sized to the full bore of the passageway and may be either metallic ball type or metallic butterfly type.

10.1.6 Each radiator shall be equipped with a bottom drain plug, a top vent plug and

lifting eyes.

10.1.7 Location of radiators shall not block or inhibit access to any manhole, handhole or control device and shall not obstruct the view of any gauge.

10.1.8 Radiator edges shall be seam welded.

10.1.9 Radiators shall be fully assembled to the transformer in the factory prior to testing to ensure proper fit. All radiator parts removed for transformer shipment shall be shipped with the transformer and clearly marked to permit easy identification when re-installing radiators in the field. These parts shall not be shipped separately.

10.1.10 The radiators shall be hot-dip galvanized. Galvanizing shall be in accordance with ASTM A123/A 123M. Minimum average coating thickness on each radiator shall be no less than 1.8 mils (1.0 oz/ft.^{2}). Testing shall be performed on all radiators.

10.1.11 Unless specifically approved by the Owner, the radiators shall be domestically manufactured in the continental United States of America by those having particular experience and expertise in the production of cooling radiators for power transformers.

10.2 Auxiliary Cooling Equipment

10.2.1 Forced cooling equipment shall employ automatically-operated fans. Pumps will not be accepted.

10.2.1.1 All fan motors shall be rated for 240 vac, single-phase, 60 Hz nominal input.

10.2.1.2 Each fan shall be individually protected against overheating and short-circuiting so that a failure of one fan does not prevent operation of any other fan. Internal motor overload protection shall be of automatic reset type.

10.2.1.3 All cooling fans shall be equipped with one-piece metal blades, employing OSHA-compliant guards to inhibit contact by operating personnel. Fan guards shall be fabricated from stainless steel. All fan mounting hardware shall be stainless steel. All other external unpainted hardware shall be either stainless steel or non-ferrous.

10.2.1.4 The fan currents shall be measured by transducer or other such device and outputs shall be routed to appropriate I/O boards on the Transformer Monitor.

10.2.1.5 Unless specifically approved by the Owner, transformer cooling fan/motor assemblies shall be manufactured by Krenz-Vent.

10.2.2 The cooling stages shall be automatically initiated by the winding ("hot-spot") temperature calculation (and associated output contact) of the Transformer Monitor as required to provide the transformer rated capacity without exceeding the guaranteed temperature rise. For redundancy, the top oil temperature gauge contacts shall be in parallel with the output contacts of the Transformer Monitor. See example schematic in Appendix E.

10.2.2.1 Winding temperature measurement shall be accomplished with a thermal element and CT input to the Transformer Monitor as described in greater detail in Section 18 .

10.2.2.2 The temperature setpoints (winding and top oil) for automatic activation of fans shall be determined by the manufacturer and identified on the plans. Setpoints shall be programmed into transformer monitor.

10.2.3 All switches, relays, and auxiliary wiring associated with control of cooling fans shall be mounted in the main transformer control compartment.

10.2.4 The fan control circuitry shall provide selector switches allowing operating personnel to manually switch each stage of cooling fans from automatic operation to maintained continuous operation, or alternately switch fan controls off (H-O-A). The selector switches shall be separate from, and not be dependent on, the Transformer Monitor for operation. See example schematic in Appendix E.

10.2.5 The fan control circuitry shall provide a switch for operator selection of which group/bank of fans will serve as first stage. The selector switches shall be separate from, and not be dependent on, the Transformer Monitor for operation. See example schematic in Appendix E.

11.0 Bushings

11.1 All bushings shall be condenser type and shall conform to the general requirements and test procedures per IEEE C57 19.01-2000.

11.2 Bushing color shall be ANSI 70 light gray.

11.3 High side bushings shall be cover mounted in ANSI Segment 3.

11.4 Low side bushings shall be cover mounted in ANSI Segment 1.

11.5 Winding-to-bushing lead ampacity shall be greater than 1.5 times the maximum rating of the transformer.

11.6 The bushing manufacturer, style number, ampere rating, and type of lead connection shall be provided in the approval package.

11.7 Bottom connected lugs shall be two or more bolts.

11.8 Bushings shall be identified such that the bushings can be re-installed in the same location as during transformer testing.

11.9 Bushings shall be furnished with NEMA-standard TIN-PLATED 4-hole pad connectors, each having an ampacity rating equal to or greater than the ampacity of the bushing lead to which the connector attaches.

12.0 Surge Protection and Grounding

12.1 The manufacturer shall furnish metal oxide, station class surge arresters for the primary and secondary windings of the transformer.

12.2 Mounting provisions for the arresters shall be made as close as practicable to the transformer bushing while observing adequate clearances in free air to maintain the designated BIL rating of the application and maintain the performance of the arresters.

12.3 Arresters shall be equal to Ohio Brass EVP or SVN with ratings and housing requirements as shown in the Ratings Schedule in Appendix A.

12.4 Arresters shall have NEMA-standard TIN PLATED, 4-hole pad connectors for energized conductors.

12.5 The grounded terminals of the surge arresters shall be connected to the ground loop described below by a copper conductor (4/0 minimum). The conductor shall be covered with a sunlight-resistant 600-volt class insulation to prevent direct contact with the tank or other painted steel surfaces. Ground path depending solely upon the transformer tank, support brackets or other non-direct methods will not be accepted. Means shall be provided to support the conductor along the route. Mechanical clamps are preferred; zip ties and similar methods are not acceptable.

12.6 The main tank shall provide two ground pads for bonding the tank case to a substation ground grid. Grounding pads shall be sized and located at diagonally opposite corners of the tank near the base in accordance with ANSI/IEEE C57.12.10. The grounding pads shall be stainless steel; brazed or welded on the designated corners. The pads shall have two holes spaced 1-3/4" apart drilled 0.625" deep and tapped for ½-13 UNC thread. Threads shall be protected when the unit is shipped.

12.7 A vertical run of 3" x ¼" copper flat bus shall be attached to the main tank close to each of the two grounding pads. The purpose of these bus bars is to provide a high integrity current path from the grounding points near the base of the transformer to the top of the transformer tank where the XO bushing and the transformer-mounted surge arresters are to be bonded to ground.

12.7.1 The vertical runs of copper flat bus bar shall be rigidly attached to the tank structurally, but electrically isolated from the steel of the tank wall. The purpose of this isolation is to inhibit corrosive electrochemical interaction between the copper and steel materials. Polymer mounting blocks (or similar insulating material) shall be used to support the bus bar at intervals not to exceed 4 feet.

12.7.2 At the base of the transformer, the vertical runs of copper flat bus shall be bonded to the grounding pads located in Segment 1 and Segment 3 of the main tank wall. All conductor hardware and connectors shall be rated in accordance with the top forced ratings of the transformer at rated secondary voltage.

12.7.3 A continuous copper bus bar not less than 3" x ¼" shall be configured to encircle the top perimeter of the transformer tank to provide a common grounding ring for bonding the grounding end of the transformer-mounted surge arresters. This grounding ring shall be rigidly attached to the upper tank (or tank cover) structurally, but electrically isolated from the tank steel. The purpose of this isolation is to inhibit corrosive electrochemical interaction between the copper and steel materials. Polymer mounting blocks (or similar insulating material) shall attach the bus bar to the tank at spanning intervals not to exceed 4 feet.

12.7.4 At the top of the transformer, the perimeter copper bus bar shall be mechanically and electrically connected to each of the vertical 3" x ¼" copper flat bus bars in Segment 1 and Segment 3.

12.7.5 All components of the grounding bus may be shipped disassembled with the transformer. Field installation of these components (if required) shall be the responsibility of the transformer manufacturer.

12.7.6 At the top of the transformer, the XO bushing shall bond to the 3" x ¼" copper flat bus located in leftmost area of Segment 1 of the main tank via flexible stranded copper, braided copper or laminated copper straps. Duplicate flexible connections shall be provided with full redundancy of connections. Each flexible connection shall be full ampacity. Bronze bolt hardware and bushing stud connectors shall be included as appropriate for the configuration. All conductor hardware and connectors shall be rated in accordance with the maximum forced cooling ratings of the transformer at rated secondary voltage.

12.7.7 Refer to Appendix C for an illustration typical of this bus bar application.

13.0 Current Transformers

13.1 All current transformers designated for Purchaser's relaying shall be bushing type with fully distributed windings for relay service and shall be multi-ratio, with five secondary tap positions in accordance with IEEE C57.13, Table 8.

13.1.1 Bushing Current Transformers (BCT's) for relaying shall be rated either ANSI class 10C800 or 10C400 as designated by the Current Transformer Schedule in Appendix B. No BCT for relaying purposes shall be less than C400 accuracy class regardless of circumstance.

13.2 For transformers equipped with load tap changers (OLTC), the transformer shall provide at least one BCT on the secondary bushings to provide measurement of load current to the line-drop compensation (LDC) circuit of the voltage regulation control.

13.3 Winding and secondary lead insulation shall withstand without deterioration the highest temperature under maximum continuous loading of the transformer.

13.4 Each set of secondary CT taps shall be wired to a shorting-type terminal block located in the control compartment. Each block shall be labeled with a permanent method that clearly identifies each CT and each CT tap. The shorting blocks shall be physically arranged in the control compartment for easy access by field personnel and to the extent practical, the physical arrangement shall be representative of the sequential order of the actual BCT locations.

13.5 The Thermal Rating Factor (RF) of all current transformers shall be sufficient to accommodate the maximum load rating of the power transformer, but shall not be less than 2.0 for any application. The RF value of the current transformers shall be noted on the schematic diagram (and other applicable drawings) and CT nameplate.

13.6 The current transformer leads shall be brought through the tank wall or cover using a

cast resin CT barrier block.

13.7 Current transformer leads shall not be spliced. If manufacturer determines that continuous runs of conductor from the CT barrier block to shorting blocks inside the control cabinet are not practical, the Owner shall be contacted for approval.

14.0 Control Cabinet

14.1 All auxiliary wiring shall be brought to a weatherproof control cabinet. Wire connections from all power, alarm, control, and current transformer circuits shall be brought to terminal blocks in the cabinet. All terminals shall be identified.

14.1.1 For transformers equipped with LTC's, the application requires additional separate control enclosures to house LTC mechanism drive motor, control switches, and related components of the LTC control. The LTC control enclosure shall conform to the same features of construction as prescribed herein except where specifically noted otherwise. Digital controls, can be housed in main control cabinet as described herein or in a separate cabinet.

14.1.2 If rubber, polymer or similar insulating material is employed as vibration-damping mounts for the control cabinet, then the cabinet shall be electrically bonded to the main transformer tank using a bonding jumper with ampacity not less than 6 AWG copper.

14.2 Minimum dimensions for the control cabinet shall be 48 inches high by 60 inches wide and 18 inches deep (60" x 60" minimum if housing electronic control components for LTC). The control cabinet shall be located on the main tank wall of Segment 1 per Figure 1 of ANSI/IEEE C57.12.10. The elevation of the cabinet shall be positioned for easy access by operational personnel standing at the base elevation of the transformer.

14.2.1 Separate enclosures for LTC controls and the inert-gas system controls (as applicable), are exempt from these dimensional requirements. Such enclosures may be sized smaller as appropriate to the purpose, but shall be located for easy access by operational personnel standing at the base elevation of the transformer.

14.3 The control cabinet shall have drip shield and hinged double doors with removable (for easier access during wiring or maintenance) center brace and pad-lockable 3-point latching device. Doors shall latch open to at least 120 degrees from the closed position and incorporate a self-engaging restraint arm.

14.3.1 A flexible stranded copper conductor shall be affixed to each door and connected to a grounded surface of the cabinet housing to electrically bond

the door to the cabinet ground bus. Size of the bonding conductor shall not have an ampacity less than 6 AWG copper.

14.4 Exterior cabinet doors shall open to a dead-front operator panel comprised of two or more swing-out interior panel doors. The dead-front panels shall provide the mounting surface for all operator control switches, control modules, instrumentation, annunciators, receptacles, test terminals, indicator lights and similar displays / control hardware.

14.4.1 The sudden pressure seal-in relay and auxiliary devices providing similar protective trip functions shall not be installed on these swing-out door panels. All tripping relays shall be mounted on fixed surfaces within the cabinet.

14.5 All cabinet hardware shall be stainless steel.

14.6 A minimum of six inches shall be maintained between the bottom of the cabinet and any device mounted on the cabinet walls.

14.7 Cabinet shall have a removable conduit entry plate on the bottom with neoprene gasket and attachment bolts.

14.8 Cabinet heaters shall be rated for single-phase, 240 volts, but connected and sized to prevent condensation when energized at 120 volts.

14.9 Humidity levels shall be controlled by thermostat or humidistat. Heaters shall be located a sufficient distance from wiring to prevent insulation damage. Positive Temperature Coefficient heaters are acceptable.

14.10 All cabinet heaters shall be equipped with safety guards which will have a surface temperature no greater than 140ºF when the heater is in continuous operation at an ambient temperature of 100ºF.

14.11 Control cabinet shall have switch-operated light fixtures equipped with guards.

14.12 Control cabinet shall provide at least one commercial-grade duplex 20 amp 120 volt GFCI receptacle.

14.13 Control cabinet shall have ground bus with minimum dimensions of 1" wide x 16" long x 1/4" thick. Ground bar shall have 12 holes tapped for 10-32 screws. Screws, flat washers and lock washer shall be provided. All screws and washers shall be non- ferrous. A flexible stranded conductor of not less than 6 AWG copper shall be used to bond the ground bar to stud inside cabinet.

15.0 Control Wiring and Terminal Blocks

15.1 All control wiring shall be copper conductor with NEC Type SIS gray color insulation.

15.2 All interconnections for control circuits shall use single conductors unless specified otherwise.

15.2.1 Routing of single conductors for interconnections within the control cabinet shall employ PVC lashing straps, metallic retaining clips, and PVC conduit trough with removable lids.

15.2.2 Jacketed tray cable shall not be used as a substitute for wiring harnesses between terminal locations inside the control cabinet.

15.2.3 For connections from the control cabinet to external accessories (gauge contacts, relay contacts, fans, etc.) connections may employ weatherproof, jacketed cables to the extent that such cable routes are protected from physical damage by conduit, steel guards, or armored jacket. Conduit material shall be rigid steel or liquid-tight metallic flexible conduit.

15.2.4 Termination of low voltage data signals susceptible to noise interference shall use individually shielded twisted pairs with drain wire and outer PVC jacket. Drain wires shall be bonded to ground bar.

15.3 Minimum conductor sizes shall be as follows:

15.3.1 Auxiliary power wiring not less than stranded 12 AWG.

15.3.2 Bushing current secondary wiring not less than stranded 10 AWG.

15.3.3 Low voltage control wiring not less than stranded 14 AWG.

15.3.4 Data signal pairs not less than stranded 18 AWG shielded twisted pair.

15.4 All control wires and their terminations shall be clearly marked with origin and destination of the conductor.

15.4.1 All wire terminations shall bear a “from/to” label collar (adhesive tags not acceptable) immediately behind the lug to identify the terminal point at the opposite end of the wire.

15.5 All terminal connections for conductor sizes 2 AWG and smaller shall be made with pre-insulated, full-ring tongue, crimp-type lugs designed for demanding high vibration applications. Fork-type terminals, slip-on connectors, or wire nuts will

not be accepted in any control circuit.

15.6 All terminal connections for conductor sizes larger than 2 AWG shall be made with two-hole, long barrel, crimp-type lugs.

15.7 All field termination points shall be wired to multiple phenolic-double row, high barrier-type terminal blocks provided with nickel-plated brass screws and terminal pads. All screw terminations shall be with non-metric slotted screws and shall include non-ferrous lock washers. Self-contained pressure-type connector blocks will not be accepted. The manufacturer shall provide a minimum of thirty (30) spare terminal positions for future use by the Owner. These terminals shall be grouped together. The sum of unused terminals on other blocks shall not be used for this purpose.

15.7.1 Terminal blocks for termination of BCT secondary leads shall be shorting type Marathon Series 1600 SC or approved equal. All other terminal blocks shall by Marathon Series 1600 STD or approved equal.

15.8 Grommets shall be used to protect wiring passing through openings in metal barriers.

15.9 Uninsulated exposed conductor or terminal lug shall not extend beyond the sides of the terminal block or its insulating barriers.

15.10 Wire terminations shall be limited to two lugs per terminal point.

15.11 All wiring shall be point-to-point between devices with continuous conductor. Mid- span splices and taps will not be accepted.

15.12 General control and service wiring shall be terminated on barrier blocks rated 600 volts 30 amp, accepting wire ranges from 10 AWG to 16 AWG, and equivalent to Marathon 1600 series.

15.13 A thermoplastic or phenolic-barrier-type power-rated stud-type terminal block, shall be provided for field termination of the Purchaser's three-pole single-phase ac auxiliary power leads. Blocks shall be rated for 600 volts, 200 amperes and equivalent to Marathon 1423122 three-pole block with ¼-20 x 9/16 stud terminals.

15.14 A main circuit breaker adequately rated for the application shall be supplied on the ac station service main following the field terminal point of the station service input. Separate branch circuit breakers adequately rated for the application shall be supplied on the auxiliary power circuits. Branch circuits for the heaters, lighting, fans and outlet loads are to be separately protected with thermal or thermal/magnetic circuit breakers.

15.15 Manufacturer's wiring shall utilize only one side of those terminal blocks assigned for user connection to CT's, alarms, power, etc. The remaining side of these blocks shall be reserved for field connection of customer's wiring.

15.16 All auxiliary transformers, relays, contactors, alarm modules, switches, fuses, circuit breakers, indicating lamps, terminal blocks and similar components of the control system shall be identified with a permanent engraved phenolic label affixed with stainless steel screws either on, above or adjacent to the component. All controls mounted on the panel front inside the control cabinet shall be similarly identified. Identification shall correspond to the IEEE function of the device and the component identification used by the manufacturer. Where applicable, ampere ratings, on-off positions, and similar attributes shall also be labeled by permanent methods.

15.17 The manufacturer's schematic and physical wiring diagrams shall clearly identify all components of the control system, encoding the components with the same nomenclature used on the physical labels. The wiring diagrams shall illustrate a direct correlation to the physical location of such hardware.

16.0 Fittings and Accessories

16.1 Standard fittings and accessories shall be included and located in accordance with the latest edition of the applicable IEEE C57 standard unless specified otherwise.

16.2 All gauges equipped with manual-reset drag indicators shall be accessible by operating personnel standing at ground elevation. These gauges shall be located at eye level and shall be legible when standing at the control cabinet.

16.3 Electrical connection to all external gauges and relays shall be made using weatherproof metal connectors equipped with bayonet-guided keyway mating. Color coding of conductor insulation shall conform to ANSI/IEEE C57.12.10 Figure 6.

16.4 Auxiliary relays designated for tripping functions shall be securely mounted on fixed rigid panels in the control compartment. These relays shall not be mounted on swing-out panels.

16.5 All devices mounted on fixed panels shall be front connected and front mounted with the mounting holes being drilled and tapped for ease of removal.

16.6 All auxiliary relays shall be equipped with dust covers.

17.0 Transformer Monitoring Equipment

17.1 Winding Temperature (hot spot)

17.1.1 The manufacturer shall provide and install a simulated winding temperature measurement system consisting of thermal sensing equipment, current transformer, and Transformer Monitor as described herein. The transformer monitor shall take the thermal input and CT input as parameters to calculate the winding temperature. Manufacturer shall program Transformer Monitor for correct fan control.

17.1.2 The thermal well and probe for the winding temperature shall be mounted in a location that will allow field removal of the probe for calibration without need to de-energize the transformer.

17.2 Top Oil Temperature

Transformer main tank top oil temperature shall be monitored by both methods as described below.

17.2.1 Top Oil Temperature Measurement Method No. 1:

17.2.1.1 The manufacturer shall provide and install a top oil temperature measurement system equivalent to Qualitrol Series 104/TR6000; employing Bourdon tube operation, complete with thermal well, sensing bulb, capillary tubing, and remotely mounted gauge. Gauge display shall be 6-inch dial type scaled for 0-180 °C and equipped with four (4) field-adjustable switch contacts wired to the main control cabinet for control of cooling fans and for alarm monitoring. Each set of contacts shall be individually field-adjustable over a range of 95°Celsius to 125°Celsius but shall be set by the manufacturer for initiation of cooling fans and 2 stages of alarms. Fan control and alarm set points shall be noted on project drawings. Length of capillary tubing shall be as required to remotely mount the gauge at eye level within viewing distance from the main control cabinet. Manufacturer shall coordinate selection of thermal well and sensing bulb as appropriate for the application.

17.2.1.2 Alarms shall be wired to the annunciator. Alarms shall be carefully calibrated as to close contacts before fans are initiated by transformer monitor.

17.2.1.3 The probe for the top oil temperature shall be mounted in a location that will allow field removal of the probe for calibration without need to de-energize the transformer.

17.2.1.4 For redundancy, top oil contacts to control cooling fans shall be in parallel with Transformer monitor simulated winding output contacts. See example schematic in Appendix E.

17.2.2 Top Oil Temperature Measurement Method No. 2:

The manufacturer shall provide and install one Resistance Temperature Detector (RTD) and RTD thermal well for electronic sensing of the top oil temperature. Installation shall include proper selection of the RTD and connection of RTD sensor output to the SEL-2414 Transformer Monitor described in Section 18.0. Top oil temperature of LTC oil filled compartment (if specified) shall be measure by similar method.

17.3 Liquid Level

17.3.1 The manufacturer shall provide and install a magnetic liquid level gauge, equivalent to Qualitrol Series 032 equipped with 6-inch dial gauge having white marking against black background, and annotated with reference marks for HI , 25°C, and LO measurement. Gauge shall be equipped with two non-adjustable Form C contacts set to close at the minimum safe operating level of the liquid. Contact closure shall be monitored by annunciator described in section 18.0.

17.4 Rapid Pressure Rise Relay (Sudden Pressure Relay)

17.4.1 The manufacturer shall provide and install Qualitrol Rapid Pressure Rise Relay Model 900 or 910 equipped with one set of Form C tripping contacts. The relay shall be flange-mounted on a 2-inch bronze gate valve allowing isolation and removal of the relay while the transformer is in service. Mounting location of the relay on the transformer tank wall shall be subject to approval by the Purchaser.

17.4.2 The tripping contacts of the rapid pressure rise relay shall be wired by the transformer manufacturer to an auxiliary seal-in circuit to provide remote tripping and alarming of a sudden pressure rise event within the transformer.

17.4.3 Manufacturer shall provide one field test kit for relay; Qualitrol KIT-013-1.

17.4.4 The manufacturer shall provide and install Qualitrol Model 909-300 electronic seal-in relay for latched response to an operation of the rapid pressure rise relay.

17.4.4.1 The seal-in relay shall be ordered for dc power supply rating in accordance with the Purchaser's nominal dc control voltage as

noted in the ratings schedules of Appendix A.

17.4.4.2 The seal-in relay shall be installed inside the main control compartment of the transformer and shall be wired to the Form C contacts of the Qualitrol 900 or 910 series rapid pressure rise relay such that the normally closed contact input inhibits false operation of the seal-in relay.

17.4.4.3 Within the main control compartment, the latching trip contacts of the seal-in relay shall be wired to terminal blocks designated for customer use. These terminals shall be clearly identified as to purpose on all drawings and related hardware.

17.4.4.4 The latching alarm contacts of the seal-in relay shall be wired to the annunciator described herein.

17.4.4.5 Within the main control compartment, the seal-in relay shall be mounted on a fixed rigid panel in a location easily accessible by operations personnel standing at base elevation. Installation of the seal-in relay on swing-out panels is not acceptable. The mounting location shall be free of obstruction so that personnel can view alarm indicators on the relay and operate the reset pushbutton on the relay.

17.5 Pressure Relief Device

17.5.1 The manufacturer shall provide and install Qualitrol Extra Large Series Pressure Relief Device (XPRD) on the cover of the main tank.

17.5.2 The PRD shall be equipped with one set of alarm contacts (10A, 125 VDC). These contacts shall be wired to the annunciator described herein.

17.5.3 The PRD shall be equipped with a long-arm mechanically-actuated semaphore, yellow in color, to provide a local visual indication of PRD operation.

17.5.4 The PRD shall have directional discharge connected to a 6" (min.) schedule 40 or 80 PVC or aluminum pipe routed directly to a point no more than 2' above the transformer base. U-bolts or other hardware for discharge pipe shall be non-ferrous.

17.5.5 If the transformer has been specified to include an OLTC, the OLTC compartment shall be equipped with a separate mechanical pressure relief device of equal design as noted above. Specific model can be suitably adjusted for the LTC tank size. Directional discharge is not required.

17.6 Tank Pressure

17.6.1 The unit shall include a pressure-vacuum gauge; Qualitrol Model 050 series with 0 atmosphere indicating at the null position. The bi-directional range of the gauge shall be capable of displaying pressure and vacuum levels in excess of the allowable transformer limits. The gauge shall be mounted on the exterior wall at eye level from base elevation and shall include all plumbing necessary to accomplish this location. This gauge is in addition to the gauge(s) required for any inert-gas system. Gauges required for such an oil preservation system are usually isolated by valves and are useless for determining tank pressure during shipment.

18.0 Alarms, Annunciation, Measurements, Fan Control, Annunciator

18.1 Annunciators: Transformer shall be equipped with two annunciator panels configured as follows:

18.1.1 SEL 2533 Part Number 2533022330XC3X1 (Transformer manufacturer to verify compatibility)

18.1.2 Annunciators shall be located inside control cabinet on swing panel.

18.1.3 The manufacturer shall furnish and install all wiring between alarm contacts and annunciator to establish local and remote reporting of status and alarms. The transformer manufacturer shall provide a schematic diagram depicting the arrangement of the input points as specified.

18.1.4 Output contacts shall mimic input contacts and shall be wired to terminal blocks for customer use.

18.1.5 Annunciator 1 shall be programmed by the transformer manufacturer and each display shall be filled out. Inputs/Outputs shall be as follows.

- Main tank Sudden Pressure Relay Operation (63X): Input A1, Output 01
- Main Tank Pressure Relief Operation (63PR): Input A2, Output 02
- Main Tank Low Oil Level (71): Input B1, Output 03
- Stage 1 Fans Loss of AC/Undervoltage*: Input B2, Output 04
- Stage 2 Fans Loss of AC/Undervoltage*: Input C1, Output 05
- AC Service Undervoltage (27AC) : Input C2, Output 06
- DC Service Undervoltage (27DC) : Input D1, Output 07
- Winding Temp alarm 1 from TM: Input D2, Output 08
- Top oil temp alarm #1 from Gauge: Input E1, Output 09
- Top oil temp alarm #2 from Gauge: Input E2, Output 10
- Output 03 shall be programmed to close when any of the alarms are true (output to terminal block)

* In lieu of an undervoltage relay, the circuit breaker for each stage of fans can include an axillary contact that is closed when the breaker is OFF or tripped. Equivalent to accessory 1201 on a Square D QO or QOU type circuit breakers.

18.1.6 Annunciator 2 shall be programmed by the transformer manufacturer and each display shall be filled out. Inputs/Outputs shall be as follows.

- LTC Sudden Pressure Relay Operation (63X): Input A1, Output 01
- LTC Pressure Relief Operation (63PR): Input A2, Output 02
- LTC Oil Temperature Alarm (from 2414): Input B1, Output 03
- LTC Low Oil Level (71): Input B2, Output 04
- LTC AC Service Undervoltage (27AC) : Input C1, Output 05
- LTC Lower Limit: Input C2, Output 06
- LTC Upper limit: Input D1, Output 07
- Low Nitrogen Cylinder Pressure: Input D2, Output 08
- Low Regulated Nitrogen Pressure: Input E1, Output 09
- High Regulated Nitrogen Pressure: Input E2, Output 10
- Output 03 shall be programmed to close when any of the alarms are true (output to terminal block)

18.2 Transformer Monitor: For temperature monitoring, winding temperature calculation, fan control, and other features as listed; the transformer shall be equipped with an SEL 2414 transformer monitor mounted in the main control cabinet and configured as follows.

18.2.1 Device shall be located inside control cabinet on swing panel.

18.2.2 The SEL-2414 shall perform the following basic functions:

- Utilize external top oil temperature and load current inputs to calculate hot spot winding temperature via internal thermal modeling program.
- Activate cooling fans as a result of winding temperature calculation.
- Display calculated winding temperature; initiate alarms.
- Display main tank top oil temperature utilizing external RTD input; initiate alarms.
- Display LTC top oil temperature utilizing external RTD input; initiate alarms.
- Display ambient temperature via external RTD input.
- Display various external transformer alarms via DI points as specified herein.
- Display Voltages and Currents specified herein.
- Display fan currents and utilize information to alarm for fan mis-operation.

18.2.3 The SEL-2414 power supply voltage rating shall match the Owner-furnished station battery voltage as specified in the Ratings Schedule. Ratings for the wetting voltage on all digital input boards shall also comply with this battery voltage.

18.2.4 The transformer manufacturer shall provide a schematic diagram depicting the arrangement of the input and output points as specified herein.

18.2.5 SEL Part number: 2414A2CBC9X745X1431. (Transformer manufacturer to verify compatibility)

Slot	Configuration
	Vertical Panel Mount Chassis, Touch Screen
A	PS /2DI /3DO: 24-48 Vdc (120-240Vac)Power Supply; 48 Vdc/Vac Digital Input Wetting (2)
C	4 DI (48 Vdc/Vac), 4 DO (Fast High Current)
D	10 RTD Inputs
E	3 ACI/ 3 AVI (300 Vac max/ 5 A phase)
Z	8 AI; +/- 20 mA or 0-10V
B	Processor Board; Fiber-Optic Serial with Ethernet Port, EIA 232, No IRIG, Single 100 Base-TX LC, SEL Protocols, Modbus, DNP3
	Conformal Coating

18.2.6 External Digital Input Monitoring

Transformer monitor shall be wired for the following digital inputs

- Fan bank 1 contactor: Input 101
- Fan bank 2 contactor: Input 102
- Bank 1/Bank 2 fan selector switch position indication: Input 301
- Other inputs shall be wired to terminal blocks for customer use

18.2.7 External RTD Input Monitoring and Annunciation

SEL-2414 shall provide display and virtual annunciation of RTD temperature measurements. These measurements shall be accomplished through use of the RTD input card accessory on the 2414 and appropriately matching RTDs. Measurements shall include

- Real-time Top Oil Temperature (26Q)
- Real-time Ambient Temperature

- LTC oil temperature (alarm output to go to annunciator)

18.2.8 External Analog Input Monitoring
Fan currents shall be transformed to 4-20mA or 0-10V analog inputs

- Bank 1 Fan Current
- Bank 2 Fan Current

18.2.9 Voltage and Current Inputs

18.2.9.1 Transformer monitor shall have wiring from the voltage input board to terminal blocks for customer input. HMI shall display voltages

18.2.9.2 Transformer monitor shall have the high side/bottom CTs (4-5-6 in Appendix B) wired, via CT shorting block, to the current input board. HMI shall display currents.

18.2.10 Hot spot winding temperature calculation, fan control and alarm:

18.2.10.1 The SEL-2414 shall calculate, via thermal model, the hot spot winding temperature. Measurement shall be accomplished through use of the top oil temperature measurement and current inputs described elsewhere herein.

18.2.10.2 The monitor shall initiate the first and second stage fan operation based upon the winding temperature calculation and setpoints as determined by the manufacturer. Outputs 301 and 302 shall control fans.

18.2.10.3 A logic statement utilizing the fan contactor inputs, selector switch position, and fan currents shall be used to generate alarms if cooling fans are called for and fans do not come on (or are not already on). Fan bank #1 and fan bank #2 failure alarms shall initiate outputs 303 and 304. These outputs shall be wired to terminal blocks for customer use. Alarms shall illuminate LED on HMI. Alarm to be reset with corresponding pushbutton.

18.2.10.4 Winding temperature calculation shall be used to initiate two levels of alarms with set points as determined by the manufacturer. The first alarm shall initiate output 101 the TM. Output shall be wired to the annunciator. Alarms shall illuminate LED on HMI. Alarm to be reset with corresponding pushbutton. Alarms limits shall be carefully chosen as to not be so close to fan

initiation as to alarm before fans come on.

18.2.10.5 The manufacturer shall program the transformer monitor for calculation of temperature and subsequent fan control and alarm operation.

18.2.11 Power Input & Voltage Rating

DC power input to the SEL-2414 shall be a protected branch circuit independently fused from the main dc supply. Power supply wiring shall be configured to allow isolation of the SEL-2414 without interfering with auxiliary DC service circuits.

18.2.12 All transformer monitor programming is the responsibility of the transformer manufacturer,

19.0 Auxiliary Equipment Power

19.1 Station Service Power will be provided by the Purchaser and is shown on the rating schedule in Appendix A.

19.2 The stationary battery bank for this application will be provided by the Purchaser. Nominal voltage rating of the battery bank is shown on the ratings schedule in Appendix A.

19.3 Maximum load requirements for AC and DC service, shall be shown on the approval drawings. AC service requirements shall include maximum kVA and amperes at nominal rated voltage. DC service requirements shall include maximum burden in watts and amperes at nominal rated voltage.

19.4 All auxiliary equipment shall be rated for operation at service voltages supplied by the Purchaser as noted in Appendix A. The manufacturer shall supply all auxiliary transformers where necessary to adjust the Purchaser's service voltage to input requirements of any auxiliary equipment with non-standard service ratings.

20.0 Sound Level

20.1 The transformer average sound level shall be 10 dB below the applicable values noted in NEMA Standard TR1-2013 (R2019) when measured in accordance with

IEEE C57.12.90.

20.2 Double wall tank construction to meet sound level is not acceptable.

20.3 The transformer design values for sound level shall be calculated in accordance with methodology prescribed by ANSI/IEEE C57.12.90 at base and top ratings. These values shall be noted in the manufacturer's proposal and referenced to the applicable value defined by NEMA TR-1.

21.0 Paint

21.1 Exterior (excluding radiators)

21.1.1 Exterior surface shall receive a full-tank shot blast.

21.1.2 Primer shall be 2 mils (minimum) of mechanically-mixed epoxy passing 500 hrs. (minimum) salt spray test.

21.1.3 Finish coat shall be 1.5 mils (minimum) of sky gray ANSI 70 polyurethane enamel salt spray test rating of 1500 hrs. (minimum).

21.1.4 Coating system performance shall be compliant with the requirements of ANSI/IEEE C57.12.28 (Padmounted Equipment-Enclosure Integrity).

21.1.5 Transformer cover and top of LTC compartment (if applicable) shall have a non-skid coating.

21.2 Interior shall be cleaned and primed prior to application of the final coat of white paint. Paint shall be a two-part epoxy system passing a 1000 hr. 130ºC accelerated aging test in transformer insulating oil. Core end frames shall also be painted white.

21.3 Paint specifications, application process and test results shall be included in the proposal.

22.0 Nameplates

22.1 A stainless steel nameplate, with diagram and text engraved and black filled, shall be furnished and secured to the tank by screws. The main nameplate for the transformer shall be affixed to the Segment 1 wall transformer tank next to the control cabinet.

22.1.1 The main nameplate for the transformer shall identify all characteristics and capacities of the transformer in compliance with ANSI C.57.12.00, Table 10.

22.1.2 The accuracy class and available tap ratios for each set of current transformers shall be provided on the main nameplate or on a supplemental nameplate adjacent to the main nameplate. Data for each set of current transformers shall be referenced to the CT locations on the main nameplate schematic diagram.

22.1.3 Cooling capacity, total CFM airflow, and transformer shipping weight shall be shown on the main nameplate or on a supplemental nameplate adjacent to the main nameplate.

22.1.4 Typical nameplate formatting is illustrated in Appendix D.

22.2 Where applicable, the LTC control cabinet shall provide a nameplate separate from that for the main transformer windings. The LTC nameplate shall provide the following characteristics of the LTC.

22.2.1 LTC Manufacturer, Location and Model Number
22.2.2 LTC Manufacturer's Name and Location
22.2.3 LTC Model Number
22.2.4 LTC Serial Number and Date of Manufacture
22.2.5 Nominal voltage application and BIL rating
22.2.6 Maximum rated current capacity
22.2.7 Number of LTC tap steps and per-step percentage value
22.2.8 Nominal ac control voltage
22.2.9 Oil capacity of LTC compartment
22.2.10 Rated operations between inspection maintenance
22.2.11 Rated lifetime operations

23.0 Transformer Tests

23.1 General

23.1.1 Each transformer shall be subjected to a series of tests as outlined below. All tests shall conform to the applicable test code and methodology set forth by the latest editions of the following standards.

ANSI/IEEE C57.12.90 *Standard Test Code for Liquid Immersed Distribution, Power and Regulating Transformers*

IEEE C57.98 *IEEE Guide for Transformer Impulse Tests*

NEMA TR1 *Transformers, Regulators and Reactors*

23.1.2 The tests shall be performed in the order listed herein unless specified otherwise.

23.1.3 The manufacturer shall provide the purchaser with a testing schedule no less than 4 weeks prior to the first test. The Owner shall be offered the right to attend any and all testing. Should the manufacturer change the testing schedule less than two weeks from the proposed start date the manufacturer shall coordinate testing with the Owner's schedule.

23.1.3.1 The Purchaser shall be notified immediately if the transformer fails to pass any test.

23.1.3.2 In the event of test failure, the Purchaser shall be afforded the opportunity to attend and witness any or all re-tests performed.

23.1.4 Certified test reports shall be furnished for each completed test.

23.2 Winding Resistance

Winding resistance measurement for all windings shall be provided in the Transformer Test Report for the following connections:

i. Units without LTC:

HV winding Tap A
HV winding Tap C
HV winding Tap E

ii. Units with LTC:

HV winding Tap A; LV LTC on position 16R
HV winding Tap A; LV LTC on position N
HV winding Tap A; LV LTC on position 16L
HV winding Tap C; LV LTC on position 16R
HV winding Tap C; LV LTC on position N
HV winding Tap C; LV LTC on position 16L
HV winding Tap E; LV LTC on position 16R
HV winding Tap E; LV LTC on position N
HV winding Tap E; LV LTC on position 16L

23.3 Ratio Tests

Ratio tests shall be performed as follows:

23.3.1 Units without LTC:

HV taps A, B, C, D, and E

23.3.2 Units with LTC:

HV tap C to all LTC tap positions
HV taps A, B, C, D and E with LTC on position N

23.4 Bushing Power Factor

23.4.1 The power factor value (i.e. "Doble" test results) for all bushings of 25 kV class and above shall be furnished by the bushing manufacturer for each bushing unit.

23.4.2 All bushings of 25 kV class and above installed in the transformer shall have their power factor and capacitance recorded on the test documentation.

23.4.3 The power factor and capacitance for each bushing shall again be recorded when the transformer is tested. This information shall be listed on the certified test reports, by bushing serial number and position in transformer.

23.4.4 Power Factor and Capacitance test for C1 and C2 taps shall be performed and recorded.

23.5 Polarity and Phase Relation

Polarity tests and Phase Relation tests shall be performed at the rated voltage connection.

23.6 Excitation Tests

Tests for excitation losses and excitation current shall be performed at rated voltage, 105%, and at 110% rated voltage. These tests shall be reported at the ambient temperatures at which they are measured.

23.7 Positive Sequence Impedance and Load Loss

Tests for positive sequence impedance and load loss shall be performed at rated current on the rated voltage connection of each unit and on all tap extremes.

23.8 Temperature Tests

23.8.1 Temperature tests shall precede dielectric tests.

23.8.2 Loading and measurement shall be performed in accordance with IEEE C57.12.90, Part 11.

23.8.3 Temperature measurements shall include:

23.8.3.1 Ambient temperature

23.8.3.2 Liquid rise temperature

23.8.3.3 Average winding temperature rise

23.8.3.4 Surface temperature rise for critical metal parts

23.8.3.5 Indicated Winding Temperature

23.8.4 Acceptable methods of transformer loading to achieve temperature rise include:

23.8.4.1 Application of actual load

23.8.4.2 Application of short-circuit load

23.8.4.3 Load-back induction

23.8.5 Full Heat Run

23.8.5.1 Transformer losses shall be maintained at a level equal to those at the highest nameplate kVA rating during the performance of the heat run test.

23.8.5.2 An oil sample shall be taken per ANSI/IEEE standards before, during, and after the heat run to calculate the total combustible gas (TCG) present and a TCG production rate for each sample.

23.8.5.3 The TCG production rate shall be calculated by summing the concentrations of Hydrogen (H2), Methane (CH4), Acetylene (C2H2), Ethylene (C2H4), and Ethane (C2H6) and then dividing the increase in TCG by the duration of the heat run in hours, to obtain parts per million TCG per hour.

23.8.5.4 The carbon gas production rate shall also be calculated by summing carbon monoxide (CO) and carbon dioxide (CO2) gases and dividing by the duration of the heat run in hours to obtain parts per million of carbon gasses per hour.

23.8.5.5 The acceptable TCG production rate, per test results, shall be equal to or less than 2 ppm per hour and the carbon gas production rate equal to or less than 20 ppm per hour. Within these limits, the individual gas differentials must not exceed the following values.

H2 - 10 ppm
CH4 - 2 ppm
C2H2 - 0 ppm
C2H4 - 1 ppm
C2H6 - 2 ppm
CO - 20 ppm
CO2 - 200 ppm

23.8.5.6 If the TCG production rate, per test results, exceeds 4 ppm per hour, and/or the carbon gas production rate exceeds 60 ppm per hour, then the transformer has failed test and measures shall be taken to correct problem(s).

23.8.5.7 For test results falling between those TCG rate limits noted above, the Purchaser shall be immediately notified. Additional testing may be requested by the Purchaser. These additional tests include the following.

1. Longer duration heat run with up to 15 percent overload with frequent oil sampling for dissolved gas analysis;
2. Infra-red scanning of the transformer tank and cover at 15 percent overload to detect any possible external indication of internal hot spots;
3. Where practicable, a heat run with 15 percent overload and the cover removed, with visual examination of the oil surface for ascending gas bubbles.

23.8.6 Heat Run Tests for Duplicate Transformers

When orders are placed for multiple power transformers of identical design and manufacture, the bidder's quote shall include full testing of each unit

per the temperature tests outlined in previous sections. The manufacturer shall submit a deduct for an alternate abbreviated temperature tests and a deduct for complete elimination of temperature tests on the additional unit. Abbreviated temperature test methodology shall be described by the manufacturer at the time the manufacturer's bid is submitted.

23.9 Impulse Tests

Impulse tests shall be applied in accordance with ANSI Standard C57.12.90 and the procedure outlined in the following paragraphs.

23.9.1 Impulse tests per standard C57.12.40 shall be applied to all terminals of the transformer except the neutral terminal(s). Neutral terminals shall receive one reduced-wave and two full-wave impulse tests.

23.9.2 All impulse tests shall precede induced voltage and corona tests and shall be officially witnessed by Purchaser's representative(s) unless the Purchaser elects to forego witnessing of tests.

23.9.3 The seller may perform other impulse tests in addition to those specified, provided that:

23.9.3.1 The requirements of this specification in regard to maintaining a complete log are met.

23.9.3.2 Prior to shipment the Seller shall prove by wave comparison or other means that the transformer has not been damaged thereby.

23.9.4 During standard full-wave tests, cathode-ray oscillograms or digital traces shall be made of the currents in grounded ends of windings being tested.

23.9.5 The impulse wave to be used for standard impulse tests shall be the 1.2 x 50 microsecond wave.

23.9.6 The standard impulse tests shall be made to each of the terminals and windings of the transformer without causing flashover, failure, or damage to any part of the transformer as evidenced by standard techniques for detection. The sequence of impulse tests shall be as follows on each terminal before proceeding to the next terminal:

23.9.6.1 One reduced full wave (applicable to line and neutral terminals for both Class I and Class II transformers).

23.9.6.2 Two chopped waves (applicable to line terminals only of Class

I and Class II transformers).

23.9.6.3 One full wave (applicable to line and neutral terminals of Class I and Class II transformers).

23.9.6.4 An example of this sequence would be to do one reduced full wave on H1 then apply two chopped waves, followed by one full wave. Then proceed to H2 and repeat, etc.

23.9.7 In the event the transformer fails to pass the required impulse tests, it shall be again fully tested with ANSI Standard impulse tests at no additional cost to Purchaser.

23.10 Short Circuit Tests

When specifically required by Purchase Order, short-circuit testing shall be done in accordance with ANSI C57.12.90, Section 12. The leakage impedance measured on a per phase basis after the test series shall not differ from that measured before the test series by more than two (2) percent.

23.11 Applied Potential Tests

Transformers shall be subjected to applied potential tests in accordance with ANSI C57.12.90.

23.12 Induced Voltage Tests

Induced voltage tests per ANSI/IEEE C57.12.90 shall be made after all other insulation tests are completed.

23.12.1 Maximum values acceptable:

23.12.1.1 Corona shall be less than 100 microvolts
23.12.1.2 Apparent charge shall be less than 300 picocoulombs

23.12.2 Acceptable changes in values during tests:

23.12.2.1 Maximum acceptable increase in corona value during 60 minute test period shall be less than 30 microvolts.
23.12.2.2 Corona values must not exhibit a steadily rising trend during 60 minute test period.
23.12.2.3 There must not be any sudden, sustained increase in corona

value during last 20 minutes of test.

23.13 No-Load Losses

No-load loss shall be measured at rated voltage both before and after impulse tests. The after-impulse test reading shall be used for evaluation purposes.

23.14 Dielectric Tests for Service & Controls

Low voltage (480 volt and below) wiring for auxiliary and control wiring shall be dielectric tested per IEEE C57.12.00-2000 Table 19, Note 10. Digital control modules and similar electronic devices shall be isolated from these tests where equipment manufacturers' literature advises such precautions. Test reports shall identify items isolated for this test.

23.15 Zero Sequence Impedance

23.15.1 The zero-sequence impedance shall be measured and recorded at rated taps.

23.15.2 The voltage winding connections made for the zero sequence impedance measurements shall be specified in the test report. Zero sequence exciting voltage shall also be furnished for all three-legged core-type two winding three-phase transformers.

23.16 Core Insulation Resistance

Core insulation resistance test shall be made immediately prior to shipment. The core insulation resistance shall have a minimum of 1000 mega-ohms. The certified test reports shall show the results of this test.

23.17 Power Factor Tests

23.17.1 Insulation power factor and capacitance for each winding and between windings shall be measured and recorded.

23.17.2 After completion of all other tests, a power factor test shall be conducted with bushings and oil in place. Such tests shall be conducted as follows:

Two-Winding Transformers

	Winding	**Winding**	**Winding**
Test No.	**Energized**	**Grounded**	**Guarded**
1	High	Low	----
2	High	----	Low
3	Low	High	----

4	Low	----	High

23.17.3 All of the above tests shall be conducted using an impressed voltage of 10 kV (except where 10 kV exceeds the rating of a winding or apparatus) at 60 Hertz. Power factors resulting from these tests shall not exceed 0.5% when corrected to 20 degrees C.

23.18 Sweep Frequency Response Analysis (SFRA)

23.18.1 After factory assembly and testing a sweep frequency response analysis test shall be performed on each transformer.

23.18.2 The SFRA test shall be performed over a range of 10 Hz - 10 kHz using a Doble 500 series (or equivalent) test set.

23.18.3 Transformer manufacturer shall furnish purchaser SFRA results in hard copy and digital format. Test results shall identify manufacturer, model and serial number of test set used. Manufacturer shall also retain test results for use in future transformer condition analysis.

23.18.4 Transformer manufacturer shall perform SFRA on transformer after assembly on pad and provide results as described above. Manufacturer shall compare the two SFRA tests and note any differences with a qualified interpretation.

23.19 Current Transformer Tests

23.19.1 All current transformers shall be ratio and polarity tested after complete assembly of the transformer.

23.19.2 A copy of all manufacture's current transformer excitation curves shall be furnished with the test report.

23.20 Dew Point

All units shall have their moisture content determined just prior to shipment (minimum 24hrs. after filling with dry-air). The measurements shall be reported in terms of the dew point temperature and temperature of insulation (temperature is assumed to be the tank temperature as recorded at three feet (3') above the transformer base on the shaded side. The dew point data shall be provided to Purchaser and attached by tag to the top fill valve at the time the unit is shipped.

24.0 Certified Test Reports

24.1 Seller shall supply three certified copies of final test reports. All test reports shall comply with IEEE 1388-2000 as a minimum.

24.1.1 Each copy of the report shall note all applicable test parameters and test results and include copies of all applicable voltage and current oscillograms, illustrating magnitude and time calibrations.

24.2 Impulse Test Reports

24.2.1 Test Log: The manufacturer shall maintain a complete log of all impulse-voltages applied to the transformer terminals, including all preliminary or calibrating tests, as well as final tests.

24.2.1.1 This log shall include a description of each test including an identification code for each digital plot; a record of all test gap settings; a record of connections to all transformer terminals; a record of atmospheric conditions; a record of the number of wavefronts and values of voltages applied; and timing values for each wavefront and decay.

24.2.1.2 The log shall include a record of any observed evidence of flashover of test gaps, bushings or protectors in the test circuit; and any disturbance, or test failure, interior or exterior of the transformer.

24.2.1.3 The log of impulse tests and test-circuit drawings shall be available to the Purchaser at all times, but this is not required to be part of the certified test report.

24.2.2 Digital Waveform Plots: Digital plots shall be taken of each impulse voltage applied to transformer terminals, including all preliminary or calibrating tests, as well as final tests.

24.2.2.1 All digital plot negatives, including those of current in windings tested, shall be permanently available for Purchaser's examination at the manufacturer's plant or, alternatively, the manufacturer shall deliver this file to the Purchaser.

24.2.2.2 When reproduced in report form, waveform plots shall be formatted and arranged so that the necessary comparisons between reduced and full magnitude waves can be conveniently determined from the report.

24.2.2.3 The amplitude scaling of each test wave on the digital plot shall

be adjusted to give as large a deflection as possible. The waves intended for comparison shall be of identical amplitude.

24.2.2.4 The effect of internal-surge limiting devices on the digital plot also shall be pointed out if required.

24.2.3 Description of Test Set Up: A description, including drawings, of the general test set-up comprising impulse generator, the circuit constants used for the terminals under test, and the connection of windings not tested shall be submitted to the Purchaser in accordance with IEEE standards.

24.3 Additional Test Data

Additional information to be provided for each transformer shall include the following:

24.3.1 Core loss and exciting current at 115 percent and 117.5 percent, extrapolated from data in ANSI/IEEE C57.12.90.

24.3.2 Load losses at 100% of rated load and efficiencies at 25%, 50%, 75%, 100% and 112% of rated load only at rated voltage tap connections.

24.3.3 Regulation in percent at 1.0, 0.9, and 0.8 power factor at rated load and rated voltage taps.

24.3.4 Positive and zero sequence impedances in percent at rated tap and tap extremes of each winding combination.

24.3.5 Temperature tests on maximum loss connection at rated load for 65 °C. Reported data to include temperature rise by resistance of high voltage and low voltage windings, temperature rise of top oil by detector, winding hot-spot temperature rise by detector, and the hot-spot conductor temperature rise over top oil temperature (degree C) (hottest spot copper gradient).

24.3.6 Turns ratio between all combinations of taps and windings.

25.0 Transformer Loss Evaluation

25.1 In order to evaluate the total cost of ownership for the Purchaser the guaranteed no- load and load losses shall be stated in the proposal.

25.2 When evaluating the life cycle cost of no-load losses representing the purchaser's

anticipated cost of no-load losses over the 20-year life of the transformer will be applied. The numerical value of the A-Factor for the particular application is found in the Ratings Schedule in Appendix A.

25.3 When evaluating the life cycle cost of load losses representing the purchaser's anticipated cost of load losses over the 20-year life of the transformer will be applied. The numerical value of the B-Factor for the particular application is found in the Ratings Schedule in Appendix A.

25.4 The life cycle cost analysis formula will be as follows:

Life Cycle Cost = Initial Purchase +(A x NLL) +(B x LL)
where
Initial Purchase = Base Price and Selected Options
A = A-Factor designated in Appendix A
B = B-Factor designated in Appendix B
NLL = No-Load losses guaranteed by the manufacturer
LL = Load losses guaranteed by the manufacturer

25.5 For OLTC units the no-load losses will be evaluated using the overage of quoted losses at 1R and the average of 15R & 16R. Load losses will be evaluated at the average of 15R and 16R.

25.6 The proposal shall include documentation that verifies the accuracy of the loss measurement system in accordance with the method of NBS Technical Note 1204.

25.7 Where the loss test values provided in the Certified Test Report exceed the values used for the bid evaluation, the final payment shall be decreased by the difference in guaranteed and actual values in accordance with the formula in Section 25.4 above.

26.0 Installation

The seller shall include the cost of installation services in the base price of the unit. The seller shall also attach a detailed description of services to be provided. Services included in the base price shall include but not be limited to the following:

26.1 Comprehensive transportation from manufacturing facility to the foundation slab at the Purchaser's designated project site.

26.2 Receipt, inspection, unpacking and unloading of transformer.

26.3 Placement of transformer onto Purchaser's foundation pad, including supplementary rigging and transport services, provided that Purchaser has prepared access way to foundation.

26.3.1 Submittal information shall include all pertinent information regarding the truck configuration required to transport the transformer, including axle weights, number of axles, and minimum turning radius.

26.4 Field assembly and attachment of all accessories needed for a complete and functional unit including radiators and cooling equipment.

26.5 Oil filling to final service level.

26.5.1 If the transformer is shipped over-filled with oil the radiators should be filled from the bottom with the top header plug loosened as to prevent the trapping of gases or air pockets in the radiators. At no time should the oil level be allowed to fall below the top of the coil clamping ring. If there is insufficient oil in the transformer the filling process should be stopped and oil added. Top off oil should be added utilizing a filter press closed to the atmosphere.

26.5.2 A dielectric test should be made on a sample of oil taken from the transformer before any of the seals are broken or any covers are removed.

26.5.3 For transformers shipped without oil or if for any reason the oil level has been allowed to drop below the top of the coils an appropriate vacuum filling procedure must be utilized. The oil filling procedure shall be submitted to the Owner's engineer prior to installation.

26.6 Performance of all standard field tests required to validate warranty. Such tests and inspections shall include but not be limited to the following:

26.6.1 Inspections performed prior to and during unloading described in the "Delivery" section of these specifications.

26.6.2 Internal inspection for transformers shipped dry.

26.6.2.1 Check coil leads for insulation abrasions.

26.6.2.2 Check electrical connections and terminal boards for loose connections.

26.6.2.3 Check tap changer connections and coupling shaft and handle.

26.6.2.4 Check current transformer leads for damage.

26.6.2.5 Check core insulation resistance by removing core ground and

taking reading to ground. Factory shall provide instructions as to satisfactory reading.

26.6.2.6 Check core grounding strap for zero resistance after reconnection.

26.6.2.7 Check for evidence of shifting of the core stack such as bent or broken support structures.

26.6.2.8 Check for loose parts, tools or debris.

26.6.2.9 Check for signs of moisture or rust.

26.6.3 Internal inspection of transformer shipped oil-filled.

26.6.3.1 Check for visual indication of moisture or rust.

26.6.3.2 Check core insulation resistance by removing core ground and taking reading to ground. Factory shall provide instructions as to satisfactory reading.

26.6.3.3 Check core grounding strap for zero resistance after reconnection.

26.6.3.4 Conduct a "through the oil" visual examination of interior for evidence of damage and for loose parts or debris.

26.6.4 Ratio Test

26.6.5 Oil Dielectric Strength

26.6.6 Oil Power Factor

26.6.7 Water-in-Oil Content

26.6.8 Insulation Power Factor

26.6.9 Dew Point (Shipped-Dry transformers only)

26.6.10 Resistance of Core Ground

26.6.11 Performance of SFRA test and submittal of written comparison with results of factory SFRA test performed under 23.18.4

26.7 Performance of oil tests consisting of the following:

Liquid Screen Analysis	Gas-In-Oil
Dielectric break down	Hydrogen
Neutralization	Oxygen
Interfacial Tension	Nitrogen
Moisture Content	Methane
Color	Carbon Monoxide
Visual	Carbon Dioxide
Power Factor	Ethane
	Ethylene
	Acetylene

Bids shall include a schedule of hourly rates work extending beyond the proposed services.

27.0 Warranty

27.1 The warranty period shall be no less than 5 years and shall start as of the date of transformer energization or 6 months from the date of delivery whichever comes first.

27.2 The manufacturer shall issue a letter to the Purchaser stating that the transformer assembly, inspection and testing has been performed by or supervised by an approved agent of the manufacturer. The letter shall further state that based upon the inspection and testing that the unit qualifies for the Manufacturer's Warranty and is ready for energization.

Appendix A

Ratings Schedule

Ratings Schedule
Town of Smithfield

Hospital Road Substation
230 Hospital Road
Smithfield, NC 27577

Transformer

Voltage, V	115,000 – 13,000Y/7500 x 24,000 Y/13,860
Connection	DELTA / WYE
Cooling Class	ONAN/ONAF/ONAF
Rating, MVA 65ºC	25/33.333/41.667
Impedance	9.5%
BIL HV/LV/NEU, kV	550/150/150
Phase Shift	30º Low voltage lagging high voltage
Frequency	60 Hz
Phases	3
OLTC	YES
Taps HV	120,750/117,875/115,000/112,125/109,250
Oil Preservation System:	Inert Gas Positive Pressure

Surge Protection

	HV	LV*
MCOV, kV, rms	76	15.3/8.4
Duty Cycle, kV, rms	96	18/10
Housing	Polymer	Polymer

Loss Evaluation Criteria

A-factor (no load)	$4,700/kW
B-factor (load)	$1000/kW

* Manufacturer to supply arresters rated for higher voltage but shunted for lower voltage initial operation,.

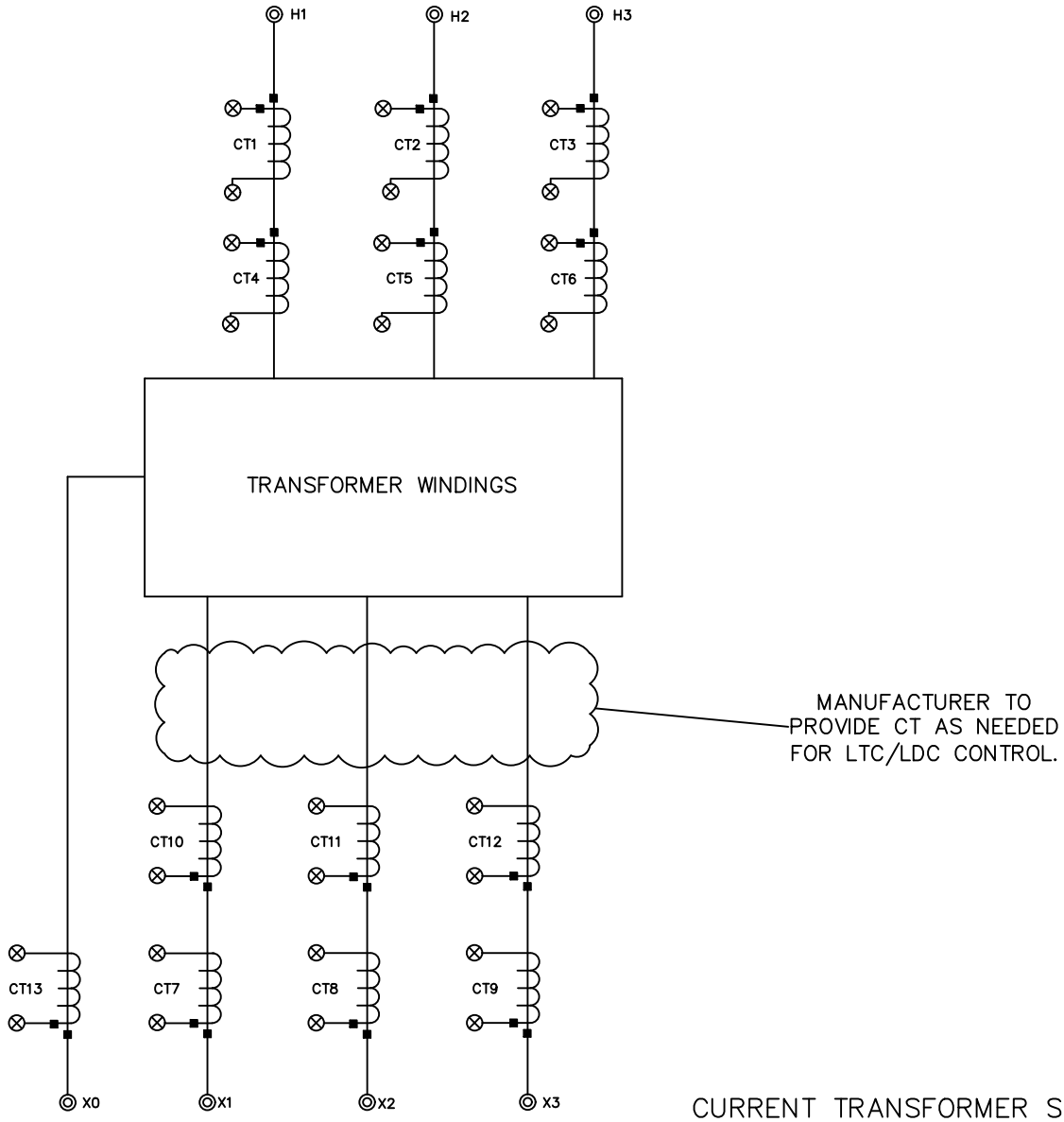
Service

Station Service Voltage, AC	120/240 1-phase
Station Battery Voltage, DC	48

Appendix B

Current Transformer Schedule

BUSHING	BCT NO.	CLASS	RATIO	APPL
H1–H2–H3	1–2–3	10C800	600:5	TOP/RELAY
H1–H2–H3	4–5–6	10C800	600:5	BOTM/TX-MONITOR
X1–X2–X3	7–8–9	10C800	2000:5	TOP/RELAY
X1–X2–X3	10–11–12	10C800	2000:5	RELAY/METER
X0	13	10C800	2000:5	GND RELAY

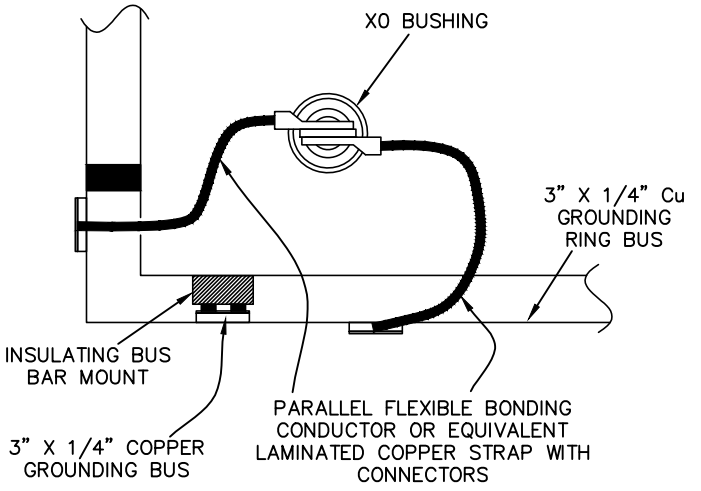


CURRENT TRANSFORMER SCHEDULE

57-001 XFMR SCHED.DWG

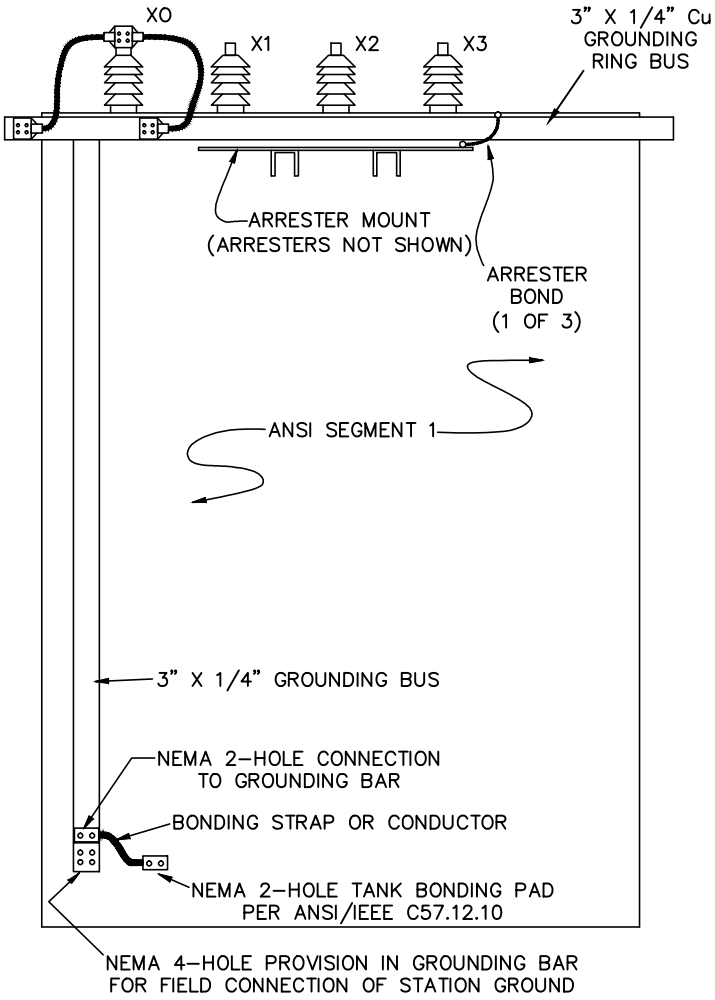
Appendix C

Ground Bus Arrangement

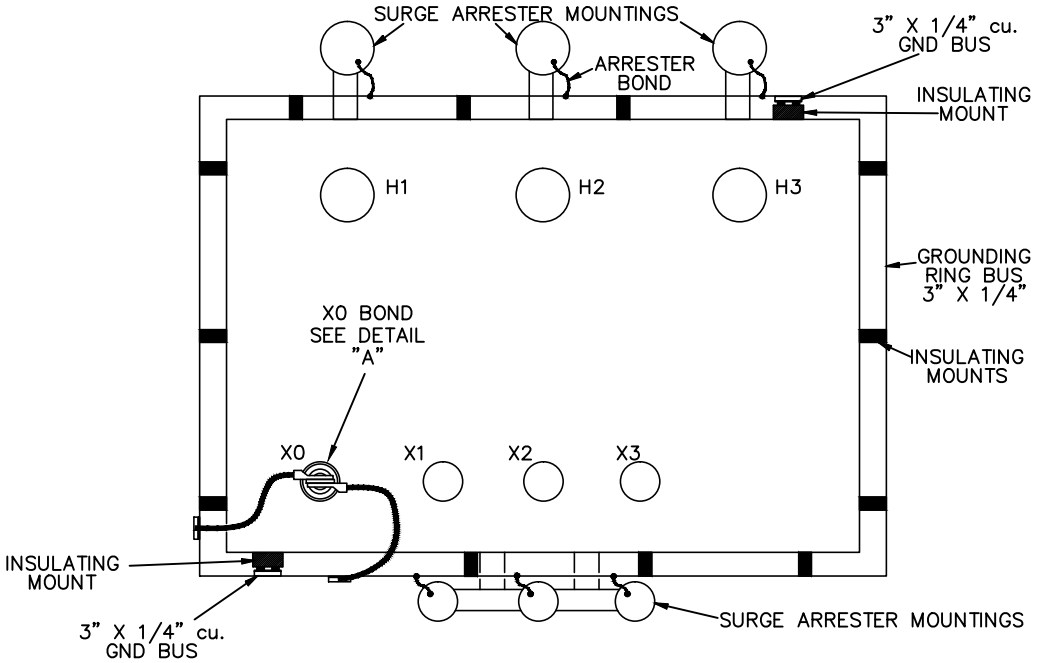


DETAIL A
BONDING CONDUCTOR ARRANGEMENT
X0 BUSHING TO GROUNDING BUS
(N.T.S.)

*NOTE:
RING BUS CAN BE ON TOP OF TRANSFORMER OR ALONG SIDE (AS SHOWN)



SECTION VIEW
GROUNDING BUS ARRANGEMENT
(N.T.S.)



PLAN VIEW
GROUNDING BUS ARRANGEMENT
(N.T.S.)

Appendix D

Typical Transformer Nameplate

Example for Illustration Only
Manufacturer May Use Standard Format
Containing Required Information and
Complying with ANSI C57.12.00 Table 10

MANUFACTURER NAME
ADDRESS

POWER TRANSFORMER

CLASS __/__/__ 3-PHASE 60 HZ

MVA __/__/__ CONT. TEMP. RISE 65°C
HV _____ VOLTS BIL ___ KV
LV _____ VOLTS BIL ___ KV
LV NEUTRAL BIL ___ KV
DESIGN NO. _____

PHASOR DIAGRAM

HIGH VOLTAGE TAPCHANGER DE-ENERGIZED OPERATION			
VOLTS L-L	AMPS AT ___ MVA	POS	CONNECTS
		A	1 - 2
		B	2 - 3
		C	3 - 4
		D	4 - 5
		E	5 - 6

LOW VOLTAGE	
VOLTS L-L	AMPS AT ___ MVA

FOR STEP DOWN OPERATION

GRAPHIC 3-LINE DIAGRAM FOR TRANSFORMER WINDINGS WITH TAPS, BUSHING DESIGNATIONS, POLARITIES, CT LOCATIONS

BUSHING CURRENT TRANSFORMER
MULIT-RATIO
ACCURACY CLASS
CT:

CURRENT RATIO	TAP	TURNS	CURRENT RATIO	TAP	TURNS
50:5	X2-X3	10	300:5	X2-X4	60
100:5	X1-X2	20	400:5	X1-X4	80
150:5	X1-X3	30	450:5	X3-X5	90
200:5	X4-X5	40	500:5	X2-X5	100
250:5	X3-X4	50	600:5	X1-X5	120

APPROXIMATE WEIGHTS		
CORE & COIL (UNTANKING WEIGHT)		
TANK, FITTINGS, AND RADIATORS		
RADS. (BOLT ON)	LBS.	
OIL-MAIN TANK	GALS.	
OIL-CONSERVATOR	GALS.	
OIL-RADIATORS	GALS.	
OIL-TOTAL	GALS.	
TOTAL WEIGHT		

* OIL MEETS ASTM D3487
NUMBER OF COOLING FANS: ___
CU FT MIN. OF EACH COOLING FAN: _____

OIL LEVEL BELOW TOP SURFACE OF THE HIGHEST POINT OF THE HIGHEST MANHOLE FLANGE AT 25°C IS ___ INCHES.

OIL LEVEL CHANGES ___ INCHES PER 10°C CHANGE IN OIL TEMPERATURE.

TANK DESIGNED FOR ___ LBF/IN^2 POSITIVE AND FULL VACUUM FILLING.

ALTITUDE 3300 FEET ABOVE SEA LEVEL
INSTRUCTION BOOK NO. ___.

BUSHING CURRENT TRANSFORMER
MULIT-RATIO
ACCURACY CLASS
CT:

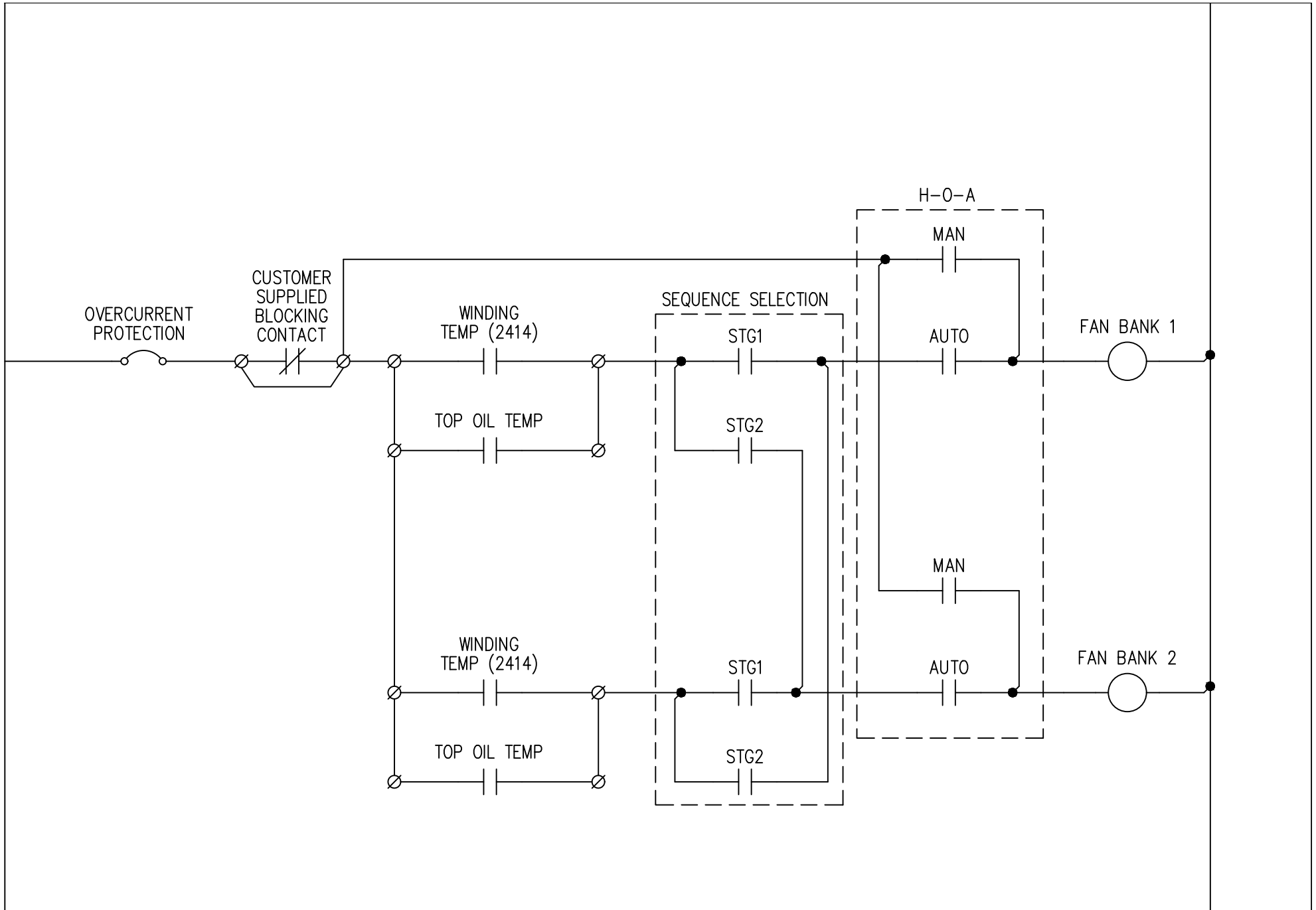
CURRENT RATIO	TAP	TURNS	CURRENT RATIO	TAP	TURNS
100:5			600:5		
200:5			800:5		
300:5			900:5		
400:5			1000:5		
500:5			1200:5		

BUSHING CURRENT TRANSFORMER
ACCURACY CLASS ___
CT: ___ FOR HOT SPOT WINDING TEMPERATURE EQUIP.
RATIO: _____
CONNECTED ON _____

IMPEDANCE @ ___ MVA	YEAR OF MFG	SERIAL NO.

Appendix E

Fan Control Schematic



FAN CONTROL SCHEMATIC

Town of Smithfield
Smithfield, North Carolina

Outdoor Power Transformer
Hospital Road Substation

Bid Schedule

DESCRIPTION	QTY	PRICE (EACH)	EXTENDED PRICE
Furnish one 25/33.333/41.667 MVA, 115 kV-13Y/7.5 x 24Y/13.856 kV power transformer in accordance with the Technical Specifications. Complete with all components in accordance with the Technical Specifications; Delivered F.O.B. to the project site or Owner's warehouse.	2	$_____	$_____

Delivery (weeks ARO): _____

Indicate if bid is FIRM or whether ESCALATION charges apply**:** _____

Furnish qualified personnel for services beyond the scope of the specification: $_____/hr

Manufacturing Location: _____

Nearest Shop Repair Facility: _____

Indicate IN-HOUSE or CONTRACT Dressout: _____

	LTC @ 1R	Avg. LTC @ 15R & 16R
Guaranteed No Load Losses		
Guaranteed Load Losses		

Notes:

1. Escalation details (if applicable) shall be clearly defined in supporting documentation.
2. Price listed above shall include manufacture, delivery, and installation. Supporting documents may break down price but total cost should be included above.
3. The Bidder shall include as a part of his proposal a list of recommended spare parts and purchase price of each.