

City of Palo Alto City Council Staff Report

Report Type: Consent Calendar Meeting Date: 10/15/2018

Summary Title: Colorado Power Station COP-2 Transformer Replacement

Title: Approval of Contract Number C19173185 With Siemens Industry, Inc. in an Amount of \$1,600,753 for the Colorado Power Station Transformer Replacement; Authorization to Negotiate and Execute Related Change Orders in the Amount of \$240,113, for a Total Not-to-Exceed Amount of \$1,840,866, and Approval of an Electric Capital Improvement Fund Budget Amendment

From: City Manager

Lead Department: Utilities

Lead Department: Utilities

Staff recommends that Council:

- 1. Approve and authorize the City Manager or his designee to execute the attached contract with Siemens Industry, Inc. (Attachment A) in an amount not to exceed of \$1,600,753 for the Colorado Power Station Transformer Replacement;
- Authorize the City Manager or his designee to negotiate and execute one or more change orders to the contract with Siemens Industry, Inc. for related additional, but unforeseen work which may develop during the project; the total of which shall not exceed \$240,113 or 15% of total contract; the total not-to-exceed amount is \$1,840,866 for the contract;
- 3. Amend the Fiscal Year 2019 Budget Appropriation Ordinance for the Electric Fund by:
 - a. Increasing the budget appropriation for the Colorado Power Equipment Upgrades project (EL-19001) by \$1,800,000;
 - b. Decreasing the budget appropriation for the Rebuild Underground Utility District 20 project (EL-14002) by \$1,250,000; and
 - c. Decreasing the budget appropriation for the VA Hospital Customer Load Requirements project (EL-17003) by \$550,000.

Background

City of Palo Alto Utilities (CPAU) owns and operates the electric system serving approximately 30,000 customers in the City. At the City's Colorado Power Station (COP), the system is fed

from an 115,000 Volt (115kV) energy source which is stepped down, or transformed, to 60,000 Volts (60kV) as it enters the City's subtransmission system, linking nine 12,000 and 4,000 Volt (12kV and 4kV, respectively) distribution substations. CPAU owns and operates three 115kV to 60kV electric power transformers at COP that supplies all power to the City of Palo Alto. On June 7, 2018, a bird caused significant damage to terminals of one of the transformers, COP-2, which requires repairs well beyond the cost of a new transformer. The damaged COP-2 was manufactured by Federal Pacific Electric Company in 1972. The lead time for procurement of a new transformer is approximately one year. The normal lifespan of these types of units is 40 to 50 years when operating near full load; however, with Palo Alto's load and based on transformer testing matrices, the expected life expectancy is higher.

Discussion

The Colorado Power Equipment replacement project (EL-19001) is a new project added to the Electric Capital Improvement plan in fiscal year 2019. The original purpose of this major project was to refurbish the three main COP electric power transformers, COP-1, COP-2, and COP-3. Staff's plan was for servicing one transformer at a time for refurbishment. However, with the recent damage on COP-2 taking one transformer out-of-service for an extended duration, there is a higher risk for outage problems if the two remaining transformers are taken out-of-service. To account for the damaged COP-2, refurbishment will be reallocated as a budget item in the following fiscal year when all three power transformers are in service and online to back each other up. Staff is proposing to repurpose the funds in EL-19001 to replace the failed COP-2 transformer first, instead of refurbishing the three transformers at this time.

CPAU will reallocate \$1,250,000 of funding from the Rebuild Underground Utility District 20 project (EL-14002). Given the recent community feedback from Green Acres for rebuilding utility underground district 15, staff is evaluating alternative system designs with pad-mounted and subsurface equipment. Staff is consulting with the Utilities Advisory Committee on this item. CPAU will also be reallocating \$550,000 from the VA Hospital Customer Load Requirements project (EL-17003) because the customer is still in the planning phase and construction will not begin until FY 2020 at the earliest.

The new replacement COP-2 transformer will be of similar dimension, size, and capacity as the existing COP-2 transformer for ease of installation and electrical matching with the other two power transformers, otherwise costs and project duration will increase significantly. Procurement will include shipping, delivery, setting in place on the existing transformer pad, preparation for energization, and testing In addition, the new transformer will be manufactured using modern manufacturing techniques including, but not limited to, lower annual energy losses. In addition to installation of the new COP-2 transformer, CPAU will be replacing the station power source which strengthens redundancy at the Colorado substation.

To aid in the procurement process, CPAU has retained an industry expert with Transformer Consulting Services, Inc. in the amount of \$20,625, to develop the functional specifications, operating characteristics, and technical data requirements of the new power transformer.

Solicitation Process

On August 16, 2018, a notice inviting a Design/Build Request for Proposals (RFP) for the Colorado Power Station COP-2 Transformer Replacement Procurement was posted at City Hall and on the Planet Bids portal. The Design/Build process was selected to allow evaluation criteria consistent with the complex technical requirements and varied exceptions that can be taken in this very competitive transformer marketplace. The industry standard for the bidding period is 5 weeks. Bids were received from five qualified bidders on September 19, 2018.

Summary of Solicitation Process

Colorado Power Station COP-2 Transformer Replacement		
Procurement		
173185		
10 months		
609		
35		
5		
Location (City, State)	Amount	
Raleigh, NC	\$1,600,753	
	Colorado Power Station COP- Procurement 173185 10 months 609 35 5 Location (City, State) Raleigh, NC	

Proposal costs ranged from \$1,600,753 to \$2,043,320.

Cost of Services

The following criteria were used during the evaluation process to identify the successful proposer:

- Proposer's compliance to Terms & Conditions and RFP requirements
- Proposer's cost.
- Proposer's references and past experience
- Proposer's schedule
- Proposer's installation and field dressing plan
- Proposer's field testing plan
- Proposer's compliance to technical specifications.

Resource Impact

The FY 2019 budget of \$900,000 appropriated in the Colorado Power Equipment Upgrades project (EL-19001), is not enough to cover the purchase and installation of a new transformer and replacement of the station power source. As a result, \$1,250,000 from Rebuild Underground Utility District 20 project (EL-14002) and \$550,000 from VA Hospital Customer Load Requirement (EL-17003) are recommended to be reallocated to EL-19001, thus increasing the total EL-19001 budget amount to \$2,700,000. Potential revenue from an insurance claim that has been filed and is under review may help offset some of these expenses. After the

claim is settled, staff will submit a FY 2019 Mid-Year revenue change request for the insurance reimbursement amount. Any future budget adjustments for these three CIP projects will be subject to Council approval.

Policy Implications

The approval of this Enterprise Fund professional services contract is consistent with existing City policies. This recommendation is consistent with the Council-approved Utilities Strategic Plan (Staff Report 1880), especially the strategic objectives to: "Ensure a reliable supply of utility resources".

Environmental Review

Approval of the attached contract is categorically exempt from the California Environmental Quality Act (CEQA) pursuant to section 15302 (replacement or reconstruction of existing facilities) of the CEQA Guidelines.

Attachments:

• Attachment A - C19173185 Colorado Transformer contract



DESIGN-BUILD CONTRACT

Contract No. C19173185

City of Palo Alto

"Colorado Power Station COP-2 Transformer" Project

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DESIGN-BUILD CONTRACT

THIS DESIGN-BUILD CONTRACT ("Contract" or "Agreement") entered into on October 15, 2018 ("Execution Date") by and between the CITY OF PALO ALTO, a California chartered municipal corporation ("City"), and SIEMENS INDUSTRY, INC., a Design-Build Entity ("DBE"), is made with reference to the following:

<u>RECITALS</u>:

A. City is a municipal corporation duly organized and validly existing under the laws of the State of California with the power to carry on its business as it is now being conducted under the statutes of the State of California and the Charter of City.

B. DBE is a corporation duly organized and in good standing in the State of Delaware, DBE's License Number 758796. DBE represents that it is duly licensed by the State of California and has the background, knowledge, experience and expertise to perform the obligations set forth in this Design-Build Contract.

C. On August 31, 2018, City issued a Request for Proposals ("RFP") to DBEs for the "Colorado Power Station COP-2 Transformer" ("Project"). In response to the RFP, DBE submitted a Proposal.

D. City and DBE desire to enter into this Design-Build Contract to provide the Design-Build Services for the Project, and other such services as identified in the Contract Documents for the Project upon the following terms and conditions.

NOW THEREFORE, in consideration of the mutual promises and undertakings hereinafter set forth and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, it is mutually agreed by and between the undersigned parties as follows:

SECTION 1 INCORPORATION OF RECITALS AND DEFINITIONS.

1.1 Recitals.

All of the recitals are incorporated herein by reference.

1.2 Definitions.

Capitalized terms shall have the meanings set forth in the RFP, this Design-Build Contract and/or in the General Conditions. If there is a conflict between the definitions in the RFP, this Design-Build Contract or in the General Conditions, the definitions in this Design-Build Contract shall prevail.

SECTION 2 THE PROJECT.

The Project is the "Colorado Power Station COP-2 Transformer" Project, located at 1082 Colorado Avenue, Palo Alto, CA 94303.

SECTION 3 THE CONTRACT DOCUMENTS.

3.1 List of Documents.

The Contract Documents (sometimes collectively referred to as "Agreement" or "Contract") consist of the following documents which are hereby incorporated by reference.

1) Change Orders

- 2) Field Orders
- 3) Design-Build Contract
- 4) RFP Addenda
- 5) Special Provisions
- 6) General Conditions
- 7) Approved Design Documents (to be developed by DBE)
- 8) Bridging Documents
- 9) Performance and Payment Bonds
- 10) Instructions to Proposers
- 11) Request for Proposals
- 12) DBE's Proposal Rev1/Non-Collusion Affidavit
- 13) Technical Specifications
- 14) Public Works Department's Standard Drawings and Specifications (most current version at time of Proposal)
- 15) Utilities Department's Water, Gas, Wastewater, Electric Utilities Standards (most current version at time of Proposal)
- 16) City of Palo Alto Traffic Control Requirements
- 17) City of Palo Alto Truck Route Map and Regulations
- 18) Preliminary Drawing REV1 (18-1137-2)
- 19) Technical Datasheet REV1 (18-1137-2)

3.2 Order of Precedence.

For the purposes of construing, interpreting and resolving inconsistencies between and among the provisions of this Contract, the Contract Documents shall have the order of precedence as set forth in the preceding section. If a claimed inconsistency cannot be resolved through the order of precedence, the City shall have the sole power to decide which document or provision shall govern as may be in the best interests of the City.

SECTION 4 DBE'S DUTY.

4.1 Relationship of Trust and Confidence. DBE accepts the relationship of trust and confidence established between it and City by this Contract. DBE agrees to furnish the Design-Build Services necessary for the design and completion of the Project and agrees to furnish efficient business administration and superintendence, and to use its best efforts to complete the Project in the best and soundest way and in the most efficient and economical manner consistent with the best interest of City.

4.1.1 DBE represents that it is an independent DBE and that it is familiar with the type of Design-Build Services it is undertaking.

4.1.2 Neither DBE nor any of its agents or employees shall act on behalf of or in the name of City unless authorized in writing by City's Representative.

4.1.3 DBE shall perform its obligations with integrity, ensuring at a minimum that conflicts of interest, including but not limited to conflicts of interests on the part of the Design Professionals employed by DBE, shall be avoided.

4.2 Scope of Services. DBE shall be responsible for procuring or providing the Design-Build Services for the Project consistent with the Contract Documents. DBE shall exercise reasonable skill and judgment in the procurement and provision of the Design-Build Services, consistent with the applicable industry practices and the terms and conditions of the Contract Documents.

4.3 Design Services.

4.3.1 **Architectural and Engineering Services.** Architectural and engineering services must be provided by licensed, independent Design Professionals retained by DBE or by licensed employees of DBE, or as permitted by the law of the State of California. DBE may not engage the services of any Design Professional for this Project without obtaining the City's prior written approval, which approval will not be unreasonably withheld. City's approval will not be deemed to create any contractual relationship between City and any such Design Professional, except that the City must be considered a third party beneficiary of such Design Professional's services for the Project. DBE must bind its Design Professionals in the same manner as DBE is bound to the City under this Contract, including, but not limited to, the insurance and indemnity requirements set forth herein. All Design Services must be guided by the Bridging Documents and Design Documents which are approved by City.

4.3.2 **Project Schedule.** Within 10 days following full execution of the Contract, DBE must prepare and submit for City's review and approval a preliminary Project Schedule showing the timing and sequencing of the Design-Build Services required to complete the Project. Unless otherwise specified by City, the preliminary Project Schedule should include the major phases for the Design Services and for the Construction Services, including, but not limited to, completion of Design Development Documents; Construction Documents; procurement of Subcontractors; construction; final close out; as well as any other milestones applicable to this Project. The Project Schedule shall be updated for City's review and approval upon completion of each milestone included in the Project Schedule.

4.3.3 **Design Development Documents.** Within 12 weeks following execution of the Contract, DBE shall prepare and submit for City's review and approval the Design Development Documents. The Design Development Documents must be based on the Bridging Documents, as may be modified by the use permit from or design approvals by City, but must further define the Project, including drawings and outline specifications fixing and describing the Project size, character and site relationships, and other appropriate elements describing the structural, architectural, mechanical and electrical systems. The Design Development Documents shall include, as applicable, plans, sections and elevations; criteria and sizing of

major components; equipment sizes and capacities and approximate layouts, including required spaces and clearances; typical details; materials selections and general quality levels. When submitting the Design Development Documents, the DBE shall identify in writing, for City's approval, all material changes and deviations that have taken place since approval of the Bridging Documents and the Project Schedule. Two printed sets and one reproducible set of Design Development Documents must be provided to the City.

4.3.4 **Construction Documents.** Within 24 weeks following City's approval of the Design Development Documents, DBE must prepare and submit for City's review and approval, Construction Documents setting forth in detail the quality levels of and the requirements for construction of the Project, and consisting of drawings and specifications that comply with applicable codes, laws, and regulations in effect at the time of their preparation at the location of the Project. The Construction Documents must also include all necessary bid and contract documents for procuring and providing the Construction Documents, the DBE shall identify in writing all for City's approval, all material changes and deviations that have taken place since approval of the Design Development Documents and Project Schedule. Two printed sets and one reproducible set of Construction Documents must be provided to the City.

4.3.5 **Ownership of Documents.**

4.3.5.1 **Ownership of Tangible Documents.** City shall receive ownership of the property rights, except for copyrights, of all documents, drawings, specifications, electronic data and information prepared, provided or procured by DBE, as part of the Design Services.

4.3.5.2 **Use of Documents in Event of Termination.** In the event of a termination of this Contract, City shall have the right to use, to reproduce, and to make derivative works of the Design Documents to complete the Project, regardless of whether there has been a transfer of copyright to City.

4.3.5.3 **City's Use of Documents After Completion of Project.** After completion of the Project, City may reuse, reproduce or make derivative works from the Design Documents solely for the purposes of maintaining, renovating, remodeling or expanding the Project.

4.3.5.4 DBE shall obtain from its Subcontractors and Design Professionals rights and rights of use that correspond to the rights given by DBE to City in this Contract and DBE shall provide evidence that such rights have been secured.

4.4 Construction Services.

4.4.1 DBE shall provide all labor, materials, equipment and services necessary to perform and timely complete the Construction Services in strict accordance with the Contract Documents, and in an economic and efficient manner in the best interests of City.

4.4.2 DBE is responsible for supervising and directing all aspects of the Work to facilitate the efficient and timely completion of the Work. DBE is solely responsible for, and required to exercise full control over, construction means, methods, techniques, sequences, procedures, and coordination of all portions of the Work, except to the extent that the Contract Documents provide other specific instructions.

4.4.3 DBE shall provide sufficient and competent Subcontractors, administration, staff, and skilled workforce necessary to perform and timely complete the Work in accordance with the Contract Documents.

4.4.4 DBE shall, at all times during performance of the Work, provide a qualified full-time superintendent, acceptable to City, and assistants, as necessary, who must be physically present at the Project site while

any aspect of the Work is being performed.

4.4.5 DBE must, at all times, ensure that the Work is performed in a good workmanlike manner and in full compliance with the Contract Documents and all applicable laws, regulations, codes, standards, and permits.

4.4.6 DBE is solely responsible to City for the acts or omissions of any party or parties performing portions of the Work or providing equipment, materials or services for or on behalf of DBE or its Subcontractors.

4.4.7 DBE shall promptly correct, at DBE's sole expense, any Work that is deficient or defective in workmanship, materials, and equipment.

4.4.8 DBE shall keep such full and detailed accounts as may be necessary for proper financial management under this Contract. City shall be afforded access to all DBE's records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda and similar data relating to Change Order work performed on the basis of actual cost. DBE shall preserve all such records for a period of three years after the Final Payment or longer where required by law.

4.4.9 DBE shall provide periodic written reports to City on the progress of the Work in such detail as is required by City and as agreed to by City and DBE.

4.5 DBE's Subcontractors.

4.5.1 All Work which is not performed by DBE with its own duly licensed forces shall be performed by Subcontractors. DBE must provide each Subcontractor with a complete set of the Construction Documents and any approved modifications thereto.

4.5.2 DBE shall require every Subcontractor and material supplier to be bound to the provisions of the Contract Documents as they apply to the Subcontractor's or material supplier's portion(s) of the Work, and to likewise bind their Subcontractors or material suppliers. City reserves the right to reject any Subcontractor or material supplier based upon City's reasonable belief that the Subcontractor or material supplier is not adequately qualified, or whose performance is unacceptable to the City, or who has a history of unacceptable performance on other public works projects. Nothing in these Contract Documents creates a contractual relationship between a Subcontractor or material supplier and City, but City shall be deemed to be a third-party beneficiary of the contract between DBE and each Subcontractor.

4.5.3 If the Contract is terminated, each subcontract agreement shall be assigned by DBE to City, subject to the prior rights of any surety, provided that the City accepts such assignment by written notification, and assumes all rights and obligations of DBE pursuant to each such subcontract agreement.

4.5.4 All Subcontractors bidding on contracts for the Work shall be afforded the applicable protections contained in the Subletting and Subcontracting Fair Practices Act (Public Contract Code Section 4100 et seq.).

4.6 Coordination of Work. City reserves the right to perform or to have performed other work on or adjacent to the Project site while the Work is being performed. DBE is responsible for coordinating its Work with other work being performed on or adjacent to the Project site, and shall avoid hindering, delaying, or interfering with the work of other contractors. To the full extent permitted by law, DBE shall hold harmless and indemnify City against any and all claims arising from or related to DBE's avoidable, negligent, or willful hindrance of, delay to, or interference with the work of another contractor or City's own forces.

4.7 DBE's Representative. DBE shall designate a person who shall be DBE's authorized representative, subject to City's approval, which shall not unreasonably be withheld.

SECTION 5 PROJECT TEAM.

In addition to DBE, City has retained, or may retain, a Design Consultant or other consultants and contractors to provide professional and technical consultation for the design and construction of the Project. The Contract requires that DBE operate efficiently, effectively and cooperatively with City as well as all other members of the Project Team and other contractors retained by City to construct other portions of the Project.

SECTION 6 TIME OF COMPLETION.

6.1 Time Is of Essence.

Time is of the essence with respect to all time limits set forth in the Contract Documents.

6.2 Commencement of Work.

DBE shall commence the Design-Build Services on the date(s) specified in City's Notice to Proceed.

6.3 Contract Time.

The Design-Build Services must begin on the date specified on the City's Notice to Proceed and shall be completed within thirty-two (32) weeks after the commencement date specified in City's Notice to Proceed.

By executing this Design-Build Contract, DBE expressly waives any claim for delayed early completion.

6.4 Liquidated Damages.

Pursuant to Government Code Section 53069.85, if DBE fails to achieve Substantial Completion of the entire Work within the Contract Time, including any approved extensions thereto, City may assess liquidated damages on a daily basis for each day of Unexcused Delay in achieving Substantial Completion, based on the amount of One Thousand dollars (\$1000.00) per day, subject to a maximum aggregate liability of an amount equal to five percent (5%) of the Contract Sum, or as otherwise specified in the Special Provisions. Liquidated damages may also be separately assessed for failure to meet milestones specified elsewhere in the Contract Documents, regardless of impact on the time for achieving Substantial Completion. The assessment of liquidated damages is not a penalty but considered to be a reasonable estimate of the amount of liquidated damages assessed against any payments otherwise due to DBE, including, but not limited to, setoff against release of retention. If the total amount of liquidated damages assessed exceeds the amount of unreleased retention, City is entitled to recover the balance from DBE or its sureties. Beneficial occupancy or use of the Project in whole or in part prior to Substantial Completion, shall not operate as a waiver of City's right to assess liquidated damages.

6.4.1 Other Remedies.

City is entitled to any and all available legal and equitable remedies City may have where City's Losses are caused by any reason other than DBE's failure to achieve Substantial Completion of the entire Work within the Contract Time.

6.5 Adjustments to Contract Time.

The Contract Time may only be adjusted for time extensions approved by City and memorialized in a Change Order approved in accordance with the requirements of the Contract Documents.

SECTION 7 COMPENSATION TO DBE.

7.1 Contract Sum.

DBE shall be compensated for satisfactory completion of the Design-Build Services in compliance with the Contract Documents the Contract Sum of One Million Six Hundred Thousand Seven Hundred Fifty Three Dollars (\$1,600,753.00).

7.2 Full Compensation.

The Contract Sum shall be full compensation to DBE for all Design-Build Services provided by DBE and, except as otherwise expressly permitted by the terms of the Contract Documents, shall cover all Losses arising out of the nature of the Design-Build Services or from the acts of the elements or any unforeseen difficulties or obstructions which may arise or be encountered in performance of the Design-Build Services until its Acceptance by City, all risks connected with the Design-Build Services, and any and all expenses incurred due to suspension or discontinuance of the Design-Build Services, except as expressly provided herein. The Contract Sum may only be adjusted for Change Orders approved in accordance with the requirements of the Contract Documents.

SECTION 8 STANDARD OF CARE.

DBE agrees that the Design-Build Services shall be performed by qualified, experienced and well-supervised personnel. All Design-Build Services performed in connection with this Design-Build Contract shall be performed in a manner consistent with the standard of care under California law applicable to those who specialize in providing such services for projects of the type, scope and complexity of the Project.

SECTION 9 INDEMNIFICATION.

9.1 Hold Harmless.

To the fullest extent permitted by law, DBE shall protect, indemnify, defend and hold harmless City, its Council members, officers, employees and agents (each an "Indemnified Party") from and against any and all demands, claims, or liabilities of any nature, including death or injury to any person, property damage or any other loss, including all costs and expenses of whatever nature including attorneys fees, experts fees, court costs and disbursements ("Claims") that arise out of, pertain to, or relate to the negligence, recklessness, or willful misconduct of the DBE, its officers, employees, agents or contractors under this Agreement, regardless of whether or not it is caused in party by an Indemnified party.

Notwithstanding the above, nothing in this section shall be construed to require DBE to indemnify an Indemnified Party from Claims arising from the active negligence, sole negligence, or willful misconduct of an Indemnified Party.

DBE shall pay City for any costs City incurs to enforce this provision. Nothing in the Contract Documents shall be construed to give rise to any implied right of indemnity in favor of DBE against City or any other Indemnitee.

Pursuant to Public Contract Code Section 9201, City shall timely notify DBE upon receipt of any third-party claim relating to the Contract.

9.2 Survival.

The acceptance of DBE's services and duties by City shall not operate as a waiver of the right of indemnification. The provisions of this Section 9 shall survive the expiration or early termination of this Agreement.

SECTION 10 NONDISCRIMINATION.

As set forth in Palo Alto Municipal Code section 2.30.510, DBE certifies that in the performance of this Agreement, it shall not discriminate in the employment of any person because of the race, skin color, gender, age, religion, disability, national origin, ancestry, sexual orientation, housing status, marital status, familial status, weight or height of such person. DBE acknowledges that it has read and understands the provisions of Section 2.30.510 of the Palo Alto Municipal Code relating to Nondiscrimination Requirements and the penalties for violation thereof, and will comply with all requirements of Section 2.30.510 pertaining to nondiscrimination in employment.

SECTION 11 INSURANCE AND BONDS.

Within ten (10) business days following issuance of the Notice of Award, DBE shall provide City with evidence satisfactory to the City that DBE has obtained insurance and has sufficient bonding capacity to provide Performance and Payment Bonds satisfying all requirements in Article 11 of the General Conditions.

SECTION 12 PROHIBITION AGAINST TRANSFERS.

City is entering into this Design-Build Contract in reliance upon the stated experience and qualifications of the DBE and its Design Professionals and Subcontractors as set forth in DBE's Proposal. Accordingly, DBE shall not assign, hypothecate or transfer this Design-Build Contract or any interest therein directly or indirectly, by operation of law or otherwise without the prior written consent of City. Any assignment, hypothecation or transfer without said consent shall be null and void, and shall be deemed a substantial breach of contract and grounds for default in addition to any other legal or equitable remedy available to the City.

The sale, assignment, transfer or other disposition of any of the issued and outstanding capital stock of DBE or of any general partner or joint venturer or syndicate member of DBE, if the DBE is a partnership or joint venture or syndicate or co-tenancy shall result in changing the control of DBE, shall be construed as an assignment of this Design-Build Contract. Control means more than fifty percent (50%) of the voting power of the corporation or other entity.

SECTION 13 NOTICES.

13.1 Method of Notice.

All notices, demands, requests or approvals to be given under this Design-Build Contract shall be given in writing and shall be deemed served on the earlier of the following:

- (i) On the date delivered if delivered personally;
- (ii) On the third business day after the deposit thereof in the United States mail, postage prepaid, and addressed as hereinafter provided;
- (iii) On the date sent if sent by facsimile transmission;
- (iv) On the date sent if delivered by electronic mail; or
- (v) On the date it is accepted or rejected if sent by certified mail.
- 13.2 Notice Recipients.

All notices, demands or requests (including, without limitation, Change Order Requests and Claims) from DBE to City shall include the Project name and the number of this Design-Build Contract and shall be addressed to City at:

- To City: City of Palo Alto City Clerk 250 Hamilton Avenue P.O. Box 10250 Palo Alto, CA 94303
- Copy to: City of Palo Alto Utilities Engineering 250 Hamilton Avenue Palo Alto, CA 94301 Attn: Jim Bujtor

In addition, copies of all Claims by DBE under this Design-Build Contract shall be provided to the following:

Palo Alto City Attorney's Office 250 Hamilton Avenue P.O. Box 10250 Palo Alto, California 94303

All Claims shall be delivered personally or sent by certified mail.

All notices, demands, requests or approvals from City to DBE shall be addressed to:

DBE Name: Siemens Industry, Inc., Richard Mucha Title: Manager of Business Development Address: 4601 Six Forks Road, Suite 500 Phone: (919)208-3908 Email: Richard.mucha@siemens.com

13.3 Change of Address.

In advance of any change of address, DBE shall notify City of the change of address in writing. Each party may, by written notice only, add, delete or replace any individuals to whom and addresses to which notice shall be provided.

SECTION 14 DEFAULT.

14.1 Notice of Default.

In the event that City determines, in its sole discretion, that DBE has failed or refused to perform any of the obligations set forth in the Contract Documents, or is in breach of any provision of the Contract Documents, City may give written notice of default to DBE in the manner specified for the giving of notices in the Design-Build Contract, with a copy to DBE's performance bond surety.

14.2 Opportunity to Cure Default.

Except for emergencies, DBE shall cure any default in performance of its obligations under the Contract Documents within two (2) Days (or such shorter time as City may reasonably require) after receipt of written notice. However, if the breach cannot be reasonably cured within such time, DBE will commence to cure the breach within two (2) Days (or such shorter time as City may reasonably require) and will diligently and continuously prosecute such cure to completion within a reasonable time, which shall in no event be later than ten (10) Days after receipt of such written notice.

SECTION 15 CITY'S RIGHTS AND REMEDIES.

15.1 Remedies Upon Default.

If DBE fails to cure any default of this Design-Build Contract within the time period set forth above in Section 14, then City may pursue any remedies available under law or equity, including, without limitation, the following:

15.1.1 Delete Certain Services.

City may, without terminating the Design-Build Contract, delete certain portions of the Design-Build Services, reserving to itself all rights to Losses related thereto.

15.1.2 Perform and Withhold.

City may, without terminating the Design-Build Contract, engage others to perform the Design-Build Services or portion thereof that has not been adequately performed by DBE and withhold the cost thereof to City from future payments to DBE, reserving to itself all rights to Losses related thereto.

15.1.3 Suspend The Design-Build Contract.

City may, without terminating the Design-Build Contract and reserving to itself all rights to Losses related thereto, suspend all or any portion of this Design-Build Contract for as long a period of time as City determines, in its sole discretion, appropriate, in which event City shall have no obligation to adjust the Contract Sum or Contract Time, and shall have no liability to DBE for damages if City directs DBE to resume Design-Build Services.

15.1.4 Terminate the Design-Build Contract for Default.

City shall have the right to terminate this Design-Build Contract, in whole or in part, upon the failure of DBE to promptly cure any default as required by Section 14. City's election to terminate the Design-Build Contract for default shall be communicated by giving DBE a written notice of termination in the manner specified for the giving of notices in the Design-Build Contract. Any notice of termination given to DBE by City shall be effective immediately, unless otherwise provided therein.

15.1.5 Invoke the Performance Bond.

City may, with or without terminating the Design-Build Contract and reserving to itself all rights to Losses related thereto, exercise its rights under the Performance Bond.

15.1.6 Additional Provisions.

All of City's rights and remedies under this Design-Build Contract are cumulative, and shall be in addition to those rights and remedies available in law or in equity. Designation in the Contract Documents of certain breaches as material shall not waive the City's authority to designate other breaches as material nor limit City's right to terminate the Design-Build Contract, or prevent the City from terminating the Agreement for breaches that are not material. City's determination of whether there has been noncompliance with the Design-Build Contract so as to warrant exercise by City of its rights and remedies for default under the Design-Build Contract, shall be binding on all parties. No termination or action taken by City after such termination shall prejudice any other rights or remedies of City provided by law or equity or by the Contract Documents upon such termination; and City may proceed against DBE to recover all liquidated damages and Losses suffered by City. Notwithstanding any provision to the contrary herein, DBE's liability under the Contract Documents for damages hereunder shall not exceed an amount equal to five (5) times the Contract Sum.

15.2 Delays by Sureties.

Time being of the essence in the performance of the Work, if DBE's surety fails to arrange for completion of the Work in accordance with the Performance Bond, within seven (7) calendar days from the date of the notice of termination, DBE's surety shall be deemed to have waived its right to complete the Work under the Contract, and City may immediately make arrangements for the completion of the Work through use of its own forces, by hiring a replacement DBE, or by any other means that City determines advisable under the circumstances. DBE and its surety shall be jointly and severally liable for any additional cost incurred by City to complete the Work following termination. In addition, City shall have the right to use any materials, supplies, and equipment belonging to DBE and located at the Worksite for the purposes of completing the remaining Work.

15.3 Damages to City.

15.3.1 For DBE's Default.

City will be entitled to recovery of all Losses under law or equity in the event of DBE's default under the Contract Documents.

15.3.2 Compensation for Losses.

In the event that City's Losses arise from DBE's default under the Contract Documents, City shall be entitled to deduct the cost of such Losses from monies otherwise payable to DBE. If the Losses incurred by City exceed the amount payable, DBE shall be liable to City for the difference and shall promptly remit same to City.

15.4 Suspension by City

15.4.1 Suspension for Convenience.

City may, at any time and from time to time, without cause, order DBE, in writing, to suspend, delay, or interrupt the Design-Build Services in whole or in part for such period of time, up to an aggregate of fifty percent (50%) of the Contract Time. The order shall be specifically identified as a Suspension Order by City. Upon receipt of a Suspension Order, DBE shall, at City's expense, comply with the order and take all reasonable steps to minimize costs allocable to the Design-Build Services covered by the Suspension Order. During the Suspension or extension of the Suspension, if any, City shall either cancel the Suspension Order or, by Change Order, delete the Design-Build Services covered by the Suspension Order. If a Suspension Order is canceled or expires, DBE shall resume and continue with the Design-Build Services. A Change Order will be issued to cover any adjustments of the Contract Sum or the Contract Time necessarily caused by such suspension. A Suspension Order shall not be the exclusive method for City to stop the Design-Build Services.

15.4.2 Suspension for Cause.

In addition to all other remedies available to City, if DBE fails to perform or correct work in accordance with the Contract Documents, City may immediately order the Design-Build Services, or any portion thereof, suspended until the cause for the suspension has been eliminated to City's satisfaction. DBE shall not be entitled to an increase in Contract Time or Contract Price for a suspension occasioned by DBE's failure to comply with the Contract Documents. City's right to suspend the Design-Build Services shall not give rise to a duty to suspend the Design-Build Services, and City's failure to suspend the Design-Build Services shall not constitute a defense to DBE's failure to comply with the requirements of the Contract Documents.

15.5 Termination Without Cause.

City may, at its sole discretion and without cause, terminate this Design-Build Contract in part or in whole upon written notice to DBE. Upon receipt of such notice, DBE shall, at City's expense, comply with the notice and take all reasonable steps to minimize costs to close out and demobilize. The compensation allowed under this Paragraph 15.5 shall be the DBE's sole and exclusive compensation for such termination and DBE waives any claim for other compensation or Losses, including, but not limited to, loss of anticipated profits, loss of revenue, lost opportunity, or other consequential, direct, indirect or incidental damages of any kind resulting from termination without cause. Termination pursuant to this provision does not relieve DBE or its sureties from any of their obligations for Losses arising from or related to the Design-Build Services performed by DBE.

15.5.1 Compensation.

Following such termination and within forty-five (45) Days after receipt of a billing from DBE seeking payment of sums authorized by this Paragraph 15.5.1, City shall pay the following to DBE as DBE's sole compensation for performance of the Design-Build Services:

.1 For Services Performed. The amount of the Contract Sum allocable to the portion of the Design-Build Services properly performed by DBE as of the date of termination, less sums previously paid to DBE.

.2 For Close-out Costs. If termination is effective after the Construction Services have commenced on the site, reasonable costs of DBE and its Subcontractors:

(i) Demobilizing and

(ii) Administering the close-out of its participation in the Project (including, without limitation, all billing and accounting functions, not including attorney or expert fees) for a period of no longer than thirty (30) Days after receipt of the notice of termination.

.3 For Fabricated Items. Previously unpaid cost of any items delivered to the Project Site which were fabricated for subsequent incorporation in the Work.

.4 **Profit Allowance.** An allowance for profit calculated as four percent (4%) of the sum of the above items, provided DBE can prove a likelihood that it would have made a profit if the Design-Build Contract had not been terminated.

.5 Emergency Termination. The compensation provided in this provision does not apply to termination for emergency pursuant to Section 2.6 of the General Conditions.

15.5.2 Subcontractors.

DBE shall include provisions in all of its subcontracts, purchase orders and other contracts permitting termination for convenience by DBE on terms that are consistent with this Design-Build Contract and that afford no greater rights of recovery against DBE than are afforded to DBE against City under this Section.

15.6 DBE's Duties Upon Termination.

Upon receipt of a notice of termination for default or for convenience, DBE shall, unless the notice directs otherwise, do the following:

- (i) Immediately discontinue the Design-Build Services to the extent specified in the notice;
- (ii) Place no further orders or subcontracts for materials, equipment, services or facilities, except as may be necessary for completion of such portion of the Work that is not discontinued;
- (iii) Provide to City a description in writing, no later than fifteen (15) days after receipt of the notice of termination, of all subcontracts, purchase orders and contracts that are outstanding, including, without limitation, the terms of the original price, any changes, payments, balance owing, the status of the portion of the Design-Build Services covered and a copy of the subcontract, purchase order or contract and any written changes, amendments or modifications thereto, together with such other information as City may determine necessary in order to decide whether to accept assignment of or request DBE to terminate the subcontract, purchase order or contract;
- (iv) Promptly assign to City those subcontracts, purchase orders or contracts, or portions thereof, that City elects to accept by assignment and cancel, on the most favorable terms reasonably possible, all subcontracts, purchase orders or contracts, or portions thereof, that City does not elect to accept by assignment; and
- (v) Thereafter do only such Design-Build Services as may be necessary to preserve and protect Design-Build Services already in progress and to protect materials, plants, and equipment on the Project Site or in transit thereto.

Upon termination, whether for cause or for convenience, the provisions of the Contract Documents remain in effect as to any Claim, indemnity obligation, warranties, guarantees, submittals of As-Built Documents, instructions, or manuals, or other such rights and obligations arising prior to the termination date.

SECTION 16 DBE'S RIGHTS AND REMEDIES.

16.1 DBE's Remedies.

DBE may terminate this Design-Build Contract only upon the occurrence of one of the following:

16.1.1 For Work Stoppage.

The Work is stopped for sixty (60) consecutive Days, through no act or fault of DBE, any Subcontractor, or any employee or agent of DBE or any Subcontractor, due to issuance of an order of a court or other public authority other than City having jurisdiction or due to an act of government, such as a declaration of a national emergency making material unavailable. This provision shall not apply to any work stoppage resulting from the City's issuance of a suspension notice issued either for cause or for convenience.

16.1.2 For City's Non-Payment.

If City does not pay DBE undisputed sums within ninety (90) Days after receipt of notice from DBE, DBE may terminate the Design-Build Contract (30) days following a second notice to City of DBE's intention to terminate the Design-Build Contract.

16.2 Damages to DBE.

In the event of termination for cause by DBE, City shall pay DBE the sums provided for in Paragraph 15.5.1 above. DBE agrees to accept such sums as its sole and exclusive compensation and agrees to waive any claim for other compensation or Losses, including, but not limited to, loss of anticipated profits, loss of revenue, lost opportunity, or other consequential, direct, indirect and incidental damages, of any kind.

SECTION 17 ACCOUNTING RECORDS.

17.1 Financial Management and City Access.

DBE shall keep full and detailed accounts and exercise such controls as may be necessary for proper financial management under this Design-Build Contract in accordance with generally accepted accounting principles and practices. City and City's accountants during normal business hours, may inspect, audit and copy DBE's records, books, estimates, take-offs, cost reports, ledgers, schedules, correspondence, instructions, drawings, receipts, subcontracts, purchase orders, vouchers, memoranda and other data relating to this Project. DBE shall retain these documents for a period of three (3) years after the later of (i) Final Payment or (ii) final resolution of all Contract Disputes and other disputes, or (iii) for such longer period as may be required by law.

17.2 Compliance with City Requests.

DBE's compliance with any request by City pursuant to this Section 17 shall be a condition precedent to filing or maintenance of any legal action or proceeding by DBE against City and to DBE's right to receive further payments under the Contract Documents. City many enforce DBE's obligation to provide access to City of its business and other records referred to in Section 17.1 for inspection or copying by issuance of a writ or a provisional or permanent mandatory injunction by a court of competent jurisdiction based on affidavits submitted to such court, without the necessity of oral testimony.

SECTION 18 INDEPENDENT PARTIES.

Each party is acting in its independent capacity and not as agents, employees, partners, or joint ventures' of the other party. City, its officers or employees shall have no control over the conduct of DBE or its respective agents, employees, subconsultants, or Subcontractors, except as herein set forth.

SECTION 19 NUISANCE.

DBE shall not maintain, commit, nor permit the maintenance or commission of any nuisance in connection in the performance of services under this Design-Build Contract.

SECTION 20 PERMITS AND LICENSES.

Except as otherwise provided in the Special Provisions and Bridging Documents, The DBE shall provide, procure and pay for all licenses, permits, and fees, required by the City or other government jurisdictions or agencies necessary to carry out and complete the Design-Build Services. Payment of all costs and expenses for such licenses, permits, and fees shall be included in one or more Proposal items. No other compensation shall be paid to the DBE for these items or for delays caused by non-City inspectors or conditions set forth in the licenses or permits issued by other agencies.

SECTION 21 WAIVER.

A waiver by either party of any breach of any term, covenant, or condition contained herein shall not be deemed to be a waiver of any subsequent breach of the same or any other term, covenant, or condition contained herein, whether of the same or a different character.

SECTION 22 GOVERNING LAW AND VENUE.

This Design-Build Contract shall be construed in accordance with and governed by the laws of the State of California, and venue shall be in a court of competent jurisdiction in the County of Santa Clara, and no other place.

SECTION 23 COMPLETE AGREEMENT.

This Agreement represents the entire and integrated agreement between the parties and supersedes all prior negotiations, representations, and contracts, either written or oral. This Agreement may be amended only by a written instrument, which is signed by the parties.

SURVIVAL OF CONTRACT.

The provisions of the Design-Build Contract which by their nature survive termination of the Design-Build Contract or Final Completion, including, without limitation, all warranties, indemnities, payment obligations, and City's right to audit DBE's books and records, shall remain in full force and effect after Final Completion or any termination or suspension of the Design-Build Contract.

SECTION 25 PREVAILING WAGES.

The DBE is required to pay general prevailing wages as defined in Subchapter 3, Title 8 of the California Code of Regulations and Section 16000 <u>et seq.</u> and Section 1773.1 of the California Labor Code. Pursuant to the provisions of Section 1773 of the Labor Code of the State of California, the City Council has obtained the general prevailing rate of per diem wages and the general rate for holiday and overtime work in this locality for each craft, classification, or type of worker needed to execute the contract for this Project from the Director of the Department of Industrial Relations. Copies of these rates may be obtained at the Purchasing Office of the City of Palo Alto. DBE shall provide a copy of prevailing wage rates to any staff or Subcontractor hired, and shall pay the adopted prevailing wage rates as a minimum. DBE shall comply with the provisions of Sections 1775, 1776, 1777.5, 1810, and 1813 of the Labor Code.

Pursuant to Labor Code section 1771.1, for any public works contract subject to Chapter 1 of Part 7 of Division 2 of the California Labor Code, for any Proposal submitted on or after March 1, 2015 and for any contract entered into on or after April 1, 2015, a contractor or subcontractor shall not be qualified to bid on or to be listed in a bid proposal subject to the requirements of section 4104 of the California Public Contract Code, unless that contractor or subcontractor is currently registered and qualified to perform public work pursuant to section 1725.5 of the California Labor Code. Notice: Pursuant to California Labor Code section 1771.4, this Project, if awarded on or after January 15, 2015, is subject to compliance monitoring and enforcement by the California Department of Industrial Relations.

SECTION 26 NON APPROPRIATION.

This Agreement is subject to the fiscal provisions of the Charter of the City of Palo Alto and the Palo Alto Municipal Code. This Agreement will terminate without any penalty (a) at the end of any fiscal year in the event that the City does not appropriate funds for the following fiscal year for this event, or (b) at any time within a fiscal year in the event that funds are only appropriated for a portion of the fiscal year and funds for this Design-Build Contract are no longer available. This section shall take precedence in the event of a conflict with any other covenant, term, condition, or provision of this Agreement.

SECTION 27 AUTHORITY.

The individuals executing this Agreement represent and warrant that they have the legal capacity and authority to do so on behalf of their respective legal entities.

SECTION 28 COUNTERPARTS

This Agreement may be signed in multiple counterparts, which shall, when executed by all the parties, constitute a single binding agreement.

SECTION 29 SEVERABILITY.

In case a provision of this Design-Build Contract is held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall not be affected.

SECTION 30 STATUTORY AND REGULATORY REFERENCES.

With respect to any amendments to any statutes or regulations referenced in these Contract Documents, the reference is deemed to be the version in effect on the date that the Contract was awarded by City, unless otherwise required by law.

SECTION 31 WORKERS' COMPENSATION CERTIFICATION.

Pursuant to Labor Code Section 1861, by signing this Contract, DBE certifies as follows: "I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the Work on this Contract."

IN WITNESS WHEREOF, the parties have caused this Design-Build Contract to be executed the date and year first above written.

CITY OF PALO ALTO	SIEMENS INDUSTRY, INC. Officer 1	
City Manager or Designee	Ву:	
	Name:	
APPROVED AS TO FORM:	Title:	
Counsel to the City of Palo Alto	Officer 2	
	Ву:	
	Name:	
	Title:	

EXHIBIT "A": TRANSFORMER SPECIFICATIONS EXHIBIT "B": PRELIMINARY DRAWING (18-1137-2) EXHIBIT "C": TECHNICAL DATA SHEET (18-1137-2) EXHIBIT "D": SIEMENS PROPOSAL REV1 EXHIBIT A

Transformer Specification

Power Transformer, All Ratings The City of Palo Alto Utilities Department

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1 Overview

1.1 **Scope**

- 1.1.1 This specification covers the requirements for furnishing, delivery to the site, assembly, installation and site testing of outdoor, 3-phase, 60-hertz power transformers for the City of Palo Alto Utilities Department (CPAU).
- 1.1.2 The transformer shall be designed and manufactured with all features to allow paralleling with a unit. The technical data of the unit to be paralleled will be provided in the Data Sheet.
- 1.1.3 When specified in the Data Sheets as replacement of an existing unit, this transformer shall be designed to meet the dimensional and weight requirements to use the existing pad. The outline drawing of the existing unit and the drawing of the existing pad will be attached with the Data Sheet.
- 1.1.4 The transformer and its accessories shall be new and suitable for the service as described in this specification.
- 1.1.5 General and detailed requirements for this transformer are covered from Section 2.0 through section 15.0 of this specification. Specific requirements are covered in the Data Sheets.

1.2 The Manufacturer's responsibilities

The Manufacturer's responsibilities shall consist of, but not be limited to the following:

- 1.2.1 Design, fabrication, and factory testing of the transformer complete with accessories, all in accordance with this specification. The Purchaser's review of drawings and/or data submitted by the Seller shall in no way relieve the Seller of responsibility for correctness of design or from consequences arising from error or omission.
- 1.2.2 Drawings and documentation in accordance with this specification.
- 1.2.3 Delivery:
 - 1.2.3.1 Transformer is to be delivered to DDP to the delivery location as identified in the Data Sheet.
 - 1.2.3.2 "Delivery to the Pad" including offloading and rigging to the foundation or alternate location identified by the Customer.
- 1.2.4 Oil fill, Assembly, installation and Testing:
 - 1.2.4.1 Assembly and installation
 - 1.2.4.2 Filling with oil (for transformers shipped without oil)
 - 1.2.4.3 Field Testing

- 1.2.5 The Manufacturer shall be responsible that any subcontractors and/or outside facilities manufacturing components for these transformers be subject to and held accountable for all terms, conditions and requirements of this specification.
- 1.2.6 All equipment and components furnished under this specification shall be guaranteed against defects in design, materials and workmanship for a period of five years after delivery and acceptance by the Customer.
 - 1.2.6.1 Guarantee shall include all in and out costs for the duration of the warranty as well as all repair and/or replacement costs. This includes all preparation for shipment, all rigging in both directions, all oil handling, and all reinstallation of same.
 - 1.2.6.2 The repair of weld leaks under warranty shall extend to all associated transformer cleaning, painting and oil work costs, and to all associated limited site clean-up costs, whether performed directly by the Manufacturer or by the Customer under the Manufacturer's direction.
 - 1.2.6.3 Acetylene levels in excess of 5 ppm within the warranty period shall be a cause for immediate joint internal inspection, at no charge to the Customer by the Manufacturer, by appropriate Manufacturer personnel and Customer personnel and possible removal, repair and/or replacement depending on results of internal inspection.
 - 1.2.6.4 Guarantee shall include joint internal inspection, at no charge to the Customer by the Manufacturer, by appropriate Manufacturer personnel and Customer personnel if Total Combustible Gas, Total Dissolved Combustible Gas or Dissolved Key Gas levels enter Condition 2 status as defined in ANSI C57.104 within the duration of the Warranty.
 - 1.2.6.5 Guarantee shall include joint internal inspection, at no charge to the Customer by the Manufacturer, by appropriate Manufacturer personnel and Customer personnel and possible removal and return to the factory for repair or replacement if Total Combustible Gas, Total Dissolved Combustible Gas or Dissolved Key Gas levels enter Condition 3 status as defined in ANSI C57.104 within the duration of the Warranty.

1.3 **The Purchaser's responsibilities**

The Purchaser's responsibilities shall consist of, but not be limited to the following:

- 1.3.1 Foundation design and installation.
- 1.3.2 Power supplies for auxiliary equipment.

2 General requirements

2.1 This specification covers technical requirements for the transformer(s) specified.

2.2 Definitions:

- 2.2.1 Purchaser/Customer: City of Palo Alto Utilities Department (CPAU)
- 2.2.2 Manufacturer/Seller: A company submitting a quotation or proposal in accordance with this specification. The company selected by the Purchaser to accept overall responsibility for fulfilling the requirements of this specification and associated General Terms and Conditions, as well as any Specific Terms and Conditions.
- 2.2.3 Engineer: Representative designated by the Customer as being responsible for technical aspects of the equipment covered by this specification.
- 2.2.4 Inspector: Representative designated by the Customer as being responsible for factory inspection, witness of factory testing, and installation aspects of the equipment covered by this specification.
- 2.3 Standards:
 - 2.3.1 Each transformer shall be designed, tested, and assembled in accordance with the latest applicable IEEE, NESC, NEMA, ICEA, ANSI, and OSHA standards, and as detailed in this specification. The Manufacturer shall notify the Purchaser of any changes in code or standards affecting this equipment. Code or standards changes after fabrication shall be reviewed by Purchaser for impact on equipment.

In addition, all structural steel shall be designed, detailed, and fabricated in accordance with the current codes of the American Institute of Steel Construction (AISC), the American Society for Testing and Materials (ASTM), and the American Welding Society (AWS).

In the event of conflicts between the standards and/or the specifications, the most stringent shall take precedence.

- 2.4 Quality assurance:
 - 2.4.1 Manufacturer shall have a Quality Assurance Program covering quality control and assurance measures imposed by him on his own work and upon sub-suppliers or subcontractors. A quality management system certified to the current ISO 9001 standard is preferred.
- 2.5 General Terms and Conditions
 - 2.5.1 will be included with the Request For Proposal.
 - 2.5.2 The transformer(s) specified may also include Specific Terms and Conditions, which will be included with the Request For Proposal.
- 2.6 Quotations/Proposals:

- 2.6.1 Proposals submitted by a Manufacturer shall provide all technical information required by the specification as well as all commercial information required in the Request For Proposal.
- 2.6.2 Proposals submitted by a Manufacturer shall include the completely filled out Purchaser's "Bid Proposal Information Worksheet".
- 2.6.3 It is the intent of this specification to be sufficiently complete so assumptions about the transformer design are not required. The Manufacturer shall be responsible for obtaining confirmation of any design assumption prior to submitting proposals.
- 2.7 Pre-award/bid meeting:
 - 2.7.1 The Customer's Engineers and the Manufacturer's Engineers, in the presence of the Customer's Purchasing Agent, may meet for a pre-award/bid meeting at the Customer's facilities to evaluate the design and design philosophy used by the Manufacturer in preparing the proposal to meet the standard and specification as well as any special requirement by the purchaser such as weight and dimension limitation, sound level restriction etc.
 - 2.7.2 The Customer prefers to purchase units having designs with proven in-service reliability but realizes that advances in technology can lead to viable new designs that both enhance reliability and reduce cost. The Manufacturer shall be allowed to present evidence of reliability for designs that do not have in-service experience to prove reliability at this meeting.
 - 2.7.3 Any design with less than 15 transformer years of service serving load or less than 2 calendar years in service serving load is considered unproven by field service. If design consists of elements that have been proven in other units but not as an integrated package, the Manufacturer shall submit experience spreadsheets broken down by design element and provide reasons why they believe the elements can be successfully integrated as proposed.
- 2.8 Communications:
 - 2.8.1 All correspondence, communications, drawings and other documentation shall be in the English language.
 - 2.8.2 All technical and commercial communications during the Request For Proposal Process shall be through the CPA Purchasing Department Representative.
 - 2.8.3 All commercial communications after the award of a Purchase Order shall be to the City of Palo Alto Purchasing Department representative named in the Purchase Order.
 - 2.8.4 All technical communications (technical questions/clarifications, drawing submittals, notifications of inspection dates, notifications of test dates, etc.) after the award of a Purchase Order shall be to the engineering contact listed on the Purchase Order.
 - 2.8.5 All shipping notifications shall be made to the Customer's representative identified on the Specific Transformer Data Sheets for that Item on the Purchase Order.

- 2.8.5.1 Two notifications shall be made: one week prior to shipment, and 48 hours prior to on-site delivery.
- 2.8.5.2 The Customer will not be responsible for any delays in shipping or receiving if the appropriate construction contact person is not notified in accordance with this specification or the Purchase Order.
- 2.9 Changes:
 - 2.9.1 Purchaser-initiated changes:
 - 2.9.1.1 The Purchaser may make changes in quantities ordered, details of the specification, and/or any drawings by written Change Order.
 - 2.9.1.2 The Change Order can also be used by the Purchaser to cancel the Purchase Order. Such cancellation shall be subject to equitable adjustment between the parties as to all work in progress but shall not include any anticipatory profits. No adjustment will be made in favor of the Manufacturer with respect to any equipment which is considered the Manufacturer's standard stock. Any claim for adjustment shall be asserted within 30 days after the date of such change or cancellation.
 - 2.9.2 Manufacturer's-initiated changes:
 - 2.9.2.1 If Manufacturer's-initiated changes are proposed for any equipment previously approved by the Purchaser, the Manufacturer can describe the changes in writing using sketches, drawings, and photographs as required.
 - 2.9.2.2 The Manufacturer should be aware that changes to equipment on past orders that were previously approved by the Purchaser, may no longer be acceptable. Therefore, any deviation to this specification shall be identified and discussed with the purchaser.

3 Documentations and inspections

- 3.1 General drawing and documentation requirements:
 - 3.1.1 All drawings and nameplates shall include measurements in US Customary Units (inches, pounds, US gallons, etc.), unless otherwise specified.
 - 3.1.2 Drawings shall be provided for each transformer being supplied in accordance with this specification. Each drawing shall contain a Title Block which includes the following information:
 - Customer's name
 - Name of substation
 - Station service voltage (AC and DC)
 - Electrical ratings of the transformer
 - Manufacturer's shop order number and drawing number.
 - Customer's Request for Quotation number.

- 3.1.3 <u>Electronic File Format</u> Electronic files of all documents shall be submitted on CD or via email in the following formats:
 - AutoCAD drawings in dwg format
 - Word Documents in PDF format
 - Photographic files in JPEG format and of appropriate resolution to print an 8"x10" image at 300 dpi with no loss of detail.
 - SFRA test results in SFRA format
 - Doble test results in pdf format, with xml files also provided.

3.1.4 <u>Nameplate Drawings</u> – shall be submitted as specified in the standard requirements.

- 3.1.5 Outline Drawings Shall include the following information:
 - 3.1.5.1 Rating of Transformer
 - 3.1.5.2 The following weight:
 - 3.1.5.2.1 Core and Coils
 - 3.1.5.2.2 Tank and associated fittings
 - 3.1.5.2.3 Main tank oil
 - 3.1.5.2.4 OLTC oil
 - 3.1.5.2.5 Radiator oil
 - 3.1.5.2.6 Main conservator oil
 - 3.1.5.2.7 Fully assembled transformer including oil (Total)
 - 3.1.5.2.8 Shipping (W/O oil)
 - 3.1.5.3 Overall size, shipping dimensions, space requirements (including that for dismantling and maintenance) and the interrelationship of the various components.
 - 3.1.5.4 Component list with OEM part numbers, voltage ratings and current ratings.
 - 3.1.5.5 The sizes of tubing, cables, and bus bars shall be indicated on this drawing.
 - 3.1.5.6 Location of the impact recorder, pressure-vacuum relief/gauge.
 - 3.1.5.7 Location of items to be removed for shipment.
 - 3.1.5.8 The location of series autotransformers, preventive autotransformers, regulating transformers and core grounds.
 - 3.1.5.9 Base dimensions and configuration, base and bushing centerlines, location of jacking pads, center of gravity and shall be suitable for designing bus connections, conduit connections and foundations.
 - 3.1.5.10 The number of radiators, and fans utilized on the transformer.
 - 3.1.5.11 The outline drawing(s) shall include plan view as well as elevation views of all four sides.
 - 3.1.5.12 Information about additional uses of the tank reinforcing bands. The drawing shall identify if bands are used as a gas expansion space, or filled with sand for sound attenuation.
 - 3.1.5.13 Where applicable, details of field erection indicating all field welds, sequence of welding, length of weld, etc. shall be provided.
 - 3.1.5.14 Torque specification table for all components requiring field assembly.
 - 3.1.5.15 The outline drawing shall indicate any requirements or restrictions related to shipping. (E.g. shipping direction, whether the transformer may or may not be rail shipped, etc.)

3.1.6 <u>Certified seismic outline drawings</u> – Shall include the following information:

- 3.1.6.1 All dimensions of each component, break down weights, the center of gravity of the transformer, loads and accelerations used in the design.
- 3.1.6.2 Anchoring details including calculation showing bolt sizes, their type, grade and locations on a plan view.
- 3.1.6.3 Calculations and details of the bracing system for the radiators. The radiators shall be braced in both the horizontal and vertical directions.
- 3.1.6.4 Controlling reactions at the base of the equipment for seismic, wind, and normal operating loads.
- 3.1.6.5 Controlling forces used for designing anchors.
- 3.1.7 <u>Schematic Diagrams</u> shall include the following information:
 - 3.1.7.1 A list of devices with manufacturer and OEM model number shall be included.
 - 3.1.7.2 Where a schematic is continued to another sheet, a transition bubble shall be used with the reference sheet # identified. Reference to separate drawings or sheets shall not be made via terminal board #'s.
 - 3.1.7.3 Terminal points shall be identified on the schematics.
 - 3.1.7.4 A typical paralleling diagram shall be provided.
 - 3.1.7.5 The alarm schematic drawing shall show the annunciator with all alarm inputs and associated field contacts on one sheet.
 - 3.1.7.6 Set-points shall be identified for devices performing alarm or control functions.
 - 3.1.7.7 Total kVA demand shall be shown for all auxiliary equipment.
- 3.1.8 Wiring Diagrams Shall be drawn using the point-to-point wiring method. Connection diagrams using the so-called "Lineless Diagram Method" with separate tabulated wire lists are unacceptable.
 - 3.1.8.1 Wiring Diagrams for all components shall be provided, including internal wiring of the LTC.
- 3.1.9 Accessory drawings and documentation:
 - 3.1.9.1 Outline drawings and details of bushings, showing stud size, connections, and dimensions.
 - 3.1.9.2 Bushing stud connector cut sheets shall be provided and shall include ampacity of connectors.
 - 3.1.9.3 A drawing showing dimensions and quantities of all gaskets.

3.1.9.4 Outline drawings of arresters, showing connections, height, and mounting details.

- 3.1.9.5 CT saturation curves and ratio correction factor curves.
- 3.1.10 Drawings Sizes. Drawings shall conform to standard drawings sizes. (Plus or minus one inch in either dimension)
 - 8-1/2" x 11" (A Size)
 - 11" x 17" (B Size)
 - 17" x 22" (C Size)
 - 22" x 34" (D Size)
- 3.2 Approval drawing transmittals:
 - 3.2.1 The Manufacturer shall submit, for review and approval by the Purchaser, Approval Drawings in accordance with the above drawing requirements and in accordance with the requirements for the transformer being supplied under this specification.
 - 3.2.2 Approval drawings shall be submitted by the date stated in the specific transformer data sheet. Prompt receipt of drawings is required to avoid cost of delays to related project activities. Liquidated damages charges will be assessed by the Purchaser per the General Terms and Conditions. A minimum of 30 days is required by the Purchaser for review and approval of these drawings.
- 3.3 Design review:
 - 3.3.1 The Purchaser shall have the option of conducting a review of the transformer.
 - 3.3.2 The Customer's Engineers and the Manufacturer's Engineers shall meet for a design review at such time after the design has been completed but before any materials that cannot be used by the Manufacturer on other orders have been procured. The Customer shall have the right to review, and the Manufacturer shall have available, all mechanical and electrical design aspects, including finite element analyses (FEA) and dielectric calculations at this meeting. Topics to be reviewed are indicated, but not limited to, the items on the checklist included with this specification. Manufacturing schedule shall allow two weeks for Customer evaluation of design review data. Any time and cost associated with redesign if design is not approved shall be borne by the Manufacturer. Any procurement and/or fabrication prior to design approval shall be at the risk of the Manufacturer. This shall apply to the first order of a given transformer or whenever modifications are made to the thermal, electrical, or mechanical of the active or live parts.
 - 3.3.3 The Manufacturer shall provide a shop schedule of major milestones to permit the Customer to schedule any in-progress inspections deemed necessary or desirable. Schedule shall be updated at regular intervals. Core and Coil Assembly and Transformer Testing shall be broken down by shift if possible.
- 3.4 Inspections and hold points:
 - 3.4.1 The Purchaser shall at any time be permitted to have his representatives visit the Manufacturer's factory to inspect the transformer or any of its parts to ascertain if the
material and processes used in the manufacture conform to this specification and if work is processing at a proper rate to meet scheduled shipment.

- 3.4.2 The Purchaser shall have the option of witnessing any or all tests performed on the transformer.
- 3.4.3 The Manufacturer shall notify the Engineer when the following points during manufacture are scheduled so that Customer representatives may be sent to inspect the equipment. At least one week's notice shall be given for each of these points. These inspections shall be considered "hold" points where work shall not proceed until the inspection is performed or the Customer waives inspection in writing. The main tank, tank cover, terminal chambers and control cabinets of one transformer should each be at least 90 percent complete and available for inspection during the core and coil inspection. Scaffolding or mobile ladders shall be available to permit inspections at the top of core and coil assemblies without climbing on the transformer.
 - 3.4.3.1 Hold point 1: the date when the core stacking and coil winding completed to permit inspection of core and winding (before windings are nested and before windings are installed on the core). The Purchaser may have an engineer sent to the factory to inspect the core & coils.
 - 3.4.3.2 Hold point 2: the date when the core and coil assemblies are completed to permit inspection of lead arrangement between coils and tap changer, tap changer mechanism and contacts, and other pertinent details. The Engineer is to be notified 30 days prior to the tanking of the active part. It is the intent that the Purchaser will have an engineer sent to the factory to inspect the core & coils assembly after the vapor phase but BEFORE insertion into the tank.

After the core and coil assemblies have been completed, preferably vpi'd and ready for insertion into the main tank.

- 3.4.3.3 Hold point 3: the date when the transformer is ready for dielectric testing, to permit witnessing of dielectric testing.
- 3.4.3.4 Hold point 4: the date when the transformer has been completely assembled, partially tested, and ready for the heat run, to permit witnessing heat run and operation of infrared recording equipment.
- 3.4.3.5 Hold point 5: the date when the transformer has been completely assembled, tested, and drained, to permit a final inspection. No equipment shall have been removed for shipment until this inspection has been completed or waived in writing, at the option of the Customer.
- 3.4.4 If Purchaser does not travel to the factory to inspect the core & coil assembly, the Manufacturer shall submit the following information prior to placing the units in VPI (or whatever final drying process the Manufacturer uses):
 - 3.4.4.1 Electronic copies of Core and Coil photographs. Photographs shall include frame filling undistorted views of all four sides and the top, plus any other views and details which would facilitate inspection and maintenance. Electronic photographs must be transmitted electronically to Engineer prior to VPI, to determine if any additional views are required.

- 3.4.4.2 Certified copy of check list filled out by the Quality Control Manager indicating that all applicable specified actions and features have been incorporated in the fabrication of the Core and Coils. Unit shall not be placed in final vapor phase until the Engineer has reviewed and approved the check list. The check list should also include any tank features already incorporated, with the understanding that all tank items may not be complete at the time the unit goes into VPI. Check list to be accompanied by electronic photographs as appropriate to verify conformance.
- 3.4.4.3 Both items above shall be used by the Customer during the Core and Coil Inspection covered elsewhere in this specification.
- 3.4.4.4 The Seller shall notify the Purchaser immediately of any damage occurring to the transformer after complete assembly or of any failure of the transformer to pass any specified quality control tests. The Purchaser shall have the option of witnessing any diagnostic action taken as the result of the above damage or failure before remedial action is initiated by the Seller.

3.5 Final Documentation:

- 3.5.1 Final documentation shall be provided within 2 weeks of shipment, and shall include the following: One (1) CD with AutoCAD drawings, test reports, SFRA data files, and photographs.
- 3.5.2 In addition to one Instruction Book provided with the transformer in the control cabinet, four (4) additional Instruction Books per transformer shall be sent to the Engineer within 4 weeks after shipment of the transformer. Each instruction book shall include the following:
 - 3.5.2.1 Instruction books shall clearly indicate the Customer's name, the substation name and number, the Purchaser's order number and the Manufacturer's identification number.
 - 3.5.2.2 Certified Test Report for each transformer, including all results of tests required in Section 13.
 - 3.5.2.3 8¹/₂" x 11" copy of the transformer nameplate drawing, with all data filled in.
 - 3.5.2.4 Assembly instructions
 - 3.5.2.5 Bill of material (identify parts removed for shipment, all parts with manufacturer name/model #, cross reference to applicable drawings by item # or electrical device #)
 - 3.5.2.6 Complete set of "As-Built" drawings (reduced size is acceptable)
 - 3.5.2.7 Arrester and Bushing outline drawings.
 - 3.5.2.8 Instructions for all accessories including Annunciator, relays, counters, Electronic Temperature Monitor (if supplied), and LTC control equipment, etc.
 - 3.5.2.9 Certified test reports for Metering accuracy CT's.
- 3.5.3 Relay class CT data. For each CT of a different accuracy class or ratio, the following information shall be supplied:
 - 3.5.3.1 Saturation curves
 - 3.5.3.2 Thermal rating factor
 - 3.5.3.3 Secondary resistance in ohms per turn
 - 3.5.3.4 Lead resistance in ohms per lead
 - 3.5.3.5 Ratio correction factor curves
 - 3.5.3.6 Metering accuracy at the full tap ratio
- 3.5.4 One (1) set of 8" x 10" color photographs as follows:

3.5.4.1 Core and coils viewed from the high voltage side, just prior to tanking

- 3.5.4.2 Core and coils viewed from the low voltage side, just prior to tanking
- 3.5.4.3 Core and coils viewed from the top, just after tanking
- 3.5.4.4 Assembled transformer side-views of the high voltage side and the low voltage side
- 3.5.4.5 Tank interior prior to tanking of active part
- 3.5.4.6 Assembled transformer top-view

4 Service conditions

- 4.1 Usual service conditions:
 - 4.1.1 The transformer will be installed outdoors and shall be suitable for operation in accordance with the usual service conditions specified in IEEE C57.12.00.
- 4.2 Loading other than rated conditions:
 - 4.2.1 All transformers specified may be exposed to an emergency loading in excess of nameplate rating, in accordance with IEEE C57.91. The transformer may be loaded above nameplate ratings in emergency situations with the knowledge that there will be some sacrifice of life.
 - 4.2.2 All transformers shall be suitable for operation with an average ambient temperature of 40°C.
- 4.3 Unusual service conditions:
 - 4.3.1 Additional special service conditions, if any, will be stated in the Specific Transformer Data Sheets. These special service conditions may include: harmonics, environmental hazards, reduced ambient air flow, etc.

5 Short-Circuit Design

- 5.1 The entire transformer shall be capable of withstanding without injury the mechanical and thermal stresses caused by short circuits (single phase, phase-to-phase, or 3-phase) on the external terminals of any winding or windings with rated voltage maintained across the other unfaulted windings all in accordance with IEEE Standard C57.12.00. In addition, the transformer shall be designed to withstand short circuit stresses for at least the time period durations indicated in the above-mentioned IEEE Standard.
- 5.2 System fault capability shall be assumed to be infinite (zero impedance).
- 5.3 The pre-fault voltage shall be assumed to be 1.10 per unit.
- 5.4 For transformers with a delta tertiary, the tertiary shall be sized to provide sufficient mechanical strength for a short circuit involving ground at the terminals of the transformer. For purposes of the mechanical and thermal attributes of the tertiary winding, an infinite source shall be assumed on the primary and the current for a fault on the secondary side shall be limited only by the impedance of the transformer.

6 Rating

- 6.1 Cooling class:
 - 6.1.1 Transformers shall be filled with a dielectric fluid as identified in the specific transformer Data Sheets.
 - 6.1.2 The circulation mechanism for the internal cooling medium shall be natural convection for all stages of cooling.
 - 6.1.3 The external cooling mechanism shall be natural or forced flow of air.
 - 6.1.4 The required number of cooling stages will be identified in the specific transformer Data Sheets.
- 6.2 Frequency:
 - 6.2.1 All transformers shall be designed for operation at 60 Hertz.
- 6.3 Phases:
 - 6.3.1 All transformers shall be three phase, with three legged core form design unless otherwise specified in specific transformer Data Sheets.
 - 6.3.2 The phase relationship of the winding is identified in the specific transformer Data Sheets.
- 6.4 Rated MVA:
 - 6.4.1 The ratings of the transformer shall be given in MVA, unless otherwise specified.
 - 6.4.2 With the maximum rated output kilovolt-ampere load at rated frequency and voltage, the average winding temperature and winding hot spot temperature shall conform to IEEE C57.12.00 with the exception of 40° ambient temperature. Specific temperature rise ratings are listed in the specific transformer Data Sheets in the Appendix.
 - 6.4.3 Specific MVA rating requirements are provided in the specific transformer Data Sheets.
- 6.5 Voltage ratings and taps:
 - 6.5.1 Voltage ratings for all windings shall be as specified in the specific transformer Data Sheets in the Appendix.
 - 6.5.2 A De-Energized Tap Changer with full capacity taps shall be provided in accordance with section 9 of this specification, and with tap voltages as identified in the specific transformer Data Sheets in the Appendix.
 - 6.5.3 A Load Tap Changer shall be provided in accordance with section 10 of this specification, and with tap voltages as identified in the specific transformer Data Sheets in the Appendix.
- 6.6 Winding terminal markings and connections:

- 6.6.1 shall be in accordance with C57.12.70, unless specified otherwise in the specific transformer Data Sheets in the Appendix.
- 6.7 Winding configurations and phase relationship:
 - 6.7.1 shall be as identified in the specific transformer Data Sheets in the Appendix.
- 6.8 Impedance:
 - 6.8.1 Positive AND Zero Sequence Impedance shall be as specified in the Data Sheets in the Appendix.
 - 6.8.2 For Wye-Wye Transformers with Delta tertiary, Zero- Sequence Impedance shall be as defined by IEEE C57.12.90. A neutral reactor is not an acceptable method for obtaining the required zero sequence impedance.
 - 6.8.3 Sufficient information for preparation of a proposal and preliminary engineering are included in the Data Sheets when parallel operation with existing transformer(s) is required. The Manufacturer shall obtain necessary detailed information from the manufacturer(s) of the existing transformer(s) after receipt of an order. In addition, the Manufacturer of transformers ordered under this specification agrees to provide such information to other Manufacturers to permit future paralleling of transformers covered by this specification as required for at least 25 years.
 - 6.8.4 The core and coil design shall be such that if the transformer were short circuit tested in accordance with ANSI C57.12.90 the impedance measured after the test series would not differ from that measured before the test series by more than two percent (2%).
- 6.9 Losses:
 - 6.9.1 Losses shall be measured in accordance with ANSI C57.12.90 using the three wattmeter method for both no load and load losses. Loss test system shall have been calibrated within 6 months prior to test.
 - 6.9.2 Losses are to be guaranteed and will be evaluated on the following basis:
 - 6.9.2.1 **No-load losses:** Based on no-load loss values taken after dielectric testing. (\$ per kW as identified in the Specific Transformer Data Sheets in the Appendix.) No-Load Loss measurements shall be guaranteed at the tap position which results in maximum excitation of all cores. (At an LTC position that results in the series transformer and/or preventive autotransformer being excited at 100% rated voltage. i.e. at 16R when only a series transformer is provided, at 15R when both series and PA transformers are provided, or 1R when only a PA is provided.)
 - 6.9.2.2 **Load losses and Cooling losses:** Based on load losses at base MVA rating. (\$ per kW as identified in the Specific Transformer Data Sheets in the Appendix.).

If load tap changing (LTC) equipment is specified, both no-load and total losses quoted in the supplier's proposal shall be the average of respective losses at five LTC positions: (1) neutral (nominal rated voltage), (2) maximum lower, (3) one position above maximum lower, (4) maximum raise, and (5) one position below maximum raise position.

- 6.9.2.3 **Total Losses:** (Total losses are the sum of no-load losses, load losses, and cooling losses.)
- 6.9.2.4 Penalty for Exceeding Guaranteed Losses: If the actual losses (no-load or total) as determined by testing (Section 13) exceed the guaranteed losses, the Seller shall pay to the Purchaser an amount determined as follows:
 - 6.9.2.4.1 (kW no-load loss per test minus kW no-load loss guaranteed) multiplied by the no-load loss evaluation figure as identified in the Specific Transformer Data Sheets in the Appendix.
 - 6.9.2.4.2 ((kW total losses per test less the kW no-load losses per test) minus (kW total losses guaranteed less the kW no-load loss guaranteed)) multiplied by the load loss evaluation figure as identified in the Specific Transformer Data Sheets in the Appendix.
 - 6.9.2.4.3 NO CREDIT WILL BE GIVEN FOR ACTUAL LOSSES WHICH ARE LESS THAN THE GUARANTEED LOSSES.
- 6.10 Insulation Levels:
 - 6.10.1 Insulation levels for line and neutral terminals shall be provided as identified in the Specific Transformer Data Sheets in the Appendix.
 - 6.10.2 Refer also to Section 13 of this specification for specific dielectric test requirements.
 - 6.10.3 Specified insulation levels shall apply to all leads and ancillary equipment associated with each terminal.
 - 6.10.4 BIL requirements shall be met without the use of internal arresters.
 - 6.10.5 No internal devices of a linear or nonlinear nature (such as surge arresters) shall be installed for any reason, that would alter, cause abnormal variations or otherwise affect factory dielectrics testing and/or affect routine maintenance test results such as "Doble" insulation power factor tests, "Doble" exciting current tests, megger tests, etc.
- 6.11 Temperature rise and loading conditions:
 - 6.11.1 Temperature rise to be as stated in the Data Sheets in the Appendix.
- 6.12 Nameplate:
 - 6.12.1 In addition to the nameplate requirements in C57.12.00, the following additional information shall be shown on the nameplate:
 - 6.12.1.1 Type of Core (example type 1, type 2 ...)
 - 6.12.1.2 Design altitude
 - 6.12.1.3 Design seismic capability
 - 6.12.1.4 Listing of the separate volumes and weights of:
 - oil in the main transformer tank
 - radiators

- conservator tank(s) (if applicable)
- LTC oil-filled compartment (if applicable)
- 6.12.1.5 Weight of the transformer prepared for shipment
- 6.12.1.6 BIL rating of neutral terminal(s)
- 6.12.1.7 Location of the buried tertiary bushing instruction plate (if applicable)
- 6.12.1.8 Y-winding voltage and capacity ratings, if applicable, whether the terminals are specified to be brought out or buried
- 6.12.1.9 Accuracy class and thermal rating factor (TRF) of current transformers
- 6.12.1.10 Location of the core and frame grounding bushing
- 6.12.1.11 Applicable instructions concerning the special bushings for a buried Y-winding and concerning the core and frame ground bushings
- 6.12.1.12 Transformer winding and current transformer polarity marks
- 6.12.1.13 Manufacturer and model number of LTC.
- 6.12.1.14 Overload rating of OLTC
- 6.12.1.15 Company PO number

7 Core

- 7.1 Steel Specification:
 - 7.1.1 All cores including main, series, and preventative auto, shall be constructed using low-loss, cold-rolled, grain-oriented, silicon steel.
 - 7.1.2 Steel is to be slit to width, annealed and coated with inorganic insulating material.
 - 7.1.3 All slits and cuts must be free of burrs.
- 7.2 Flux Density
 - 7.2.1 With the transformer energized at no-load on any tap position, at 100% voltage, the maximum flux density in any part of the core shall not exceed 1.7 Tesla.
 - 7.2.2 At the maximum forced-cooled rating, the maximum flux density in magnetic shunts shall not exceed 1.2 Tesla.
 - 7.2.3 The transformer shall be designed to meet the following ANSI overvoltage requirements, such that the maximum core flux density shall not exceed 1.9 Tesla at any tap position:
 - 110% secondary voltage at no-load

James Bujtor 105% secondary voltage with the transformer at maximum rated MVA load condition and at 80% power factor. •

- 7.2.4 On load tap changing transformers with the tertiary (Y) terminals brought out, the transformer shall be designed such that variation of the voltage output of the tertiary winding is allowed, unless otherwise stated in the Specific Transformer Data Sheets in the Appendix, that the voltage output must be constant.
- 7.2.5 The induction level shall be such that the ratio of induction current at 110% and 100% voltages shall not be >3.
- 7.3 Core design:
 - 7.3.1 The core shall be a three-legged core-form construction using mitered step lap design, unless otherwise specified in specific transformer Data Sheets in the Appendix.
 - 7.3.2 The edges of the laminations on the core legs and bottom yoke shall be protected against rust with a protective coating. The core legs shall be secured with permanent bands.
 - 7.3.3 Bolts through the legs or yokes shall not be used.
 - 7.3.4 The core internal hot-spot temperature shall be limited to a maximum of 125° C.
 - 7.3.5 Material used to form cooling ducts in the core shall not be cellulose.
 - 7.3.6 Every core step shall be supported at the ends. At the bottom every core step shall be supported from a base bar that connects to the LV and HV core clamps.
 - 7.3.7 Core frame components shall be welded or bolted using Belleville washers.
 - 7.3.8 Self-locking nuts, with stainless steel Belleville washers, or approved self-locking inserts, shall be used where required to secure equipment mounted over the core and coil assembly. Split spring lock washers are not acceptable in the assembly of internal transformer components.
 - 7.3.9 If flux shield plates and/or non-magnetic steel are used to reduce tank heating and losses, the Seller shall provide detailed drawings of these items for the Purchaser's approval.
- 7.4 Core insulation:
 - 7.4.1 The insulation material between tie bars and the core, and the core frames and core, shall be a high-temperature material (tolerant of 150° C minimum) that coordinates with the surface temperatures in the locations where this insulation is to be applied. A minimum material thickness of 2 mm shall be provided.
- 7.5 Core Grounds:
 - 7.5.1 If the core is constructed with cooling channels separated by insulating material, each core section ground shall be brought up separately through cover mounted bushings. The core sections shall be externally bonded and grounded. A bridging strap or other means of internal electrical connection of the core sections is not acceptable.

- 7.5.2 An engraved nameplate shall be provided to permanently identify the core ground connections.
- 7.5.3 All core ground connections (main and auxiliary windings) shall be brought up separately and grounded. The connections shall be brought out through a bushing mounted on the top of the tank, protected in a metal box. The bushings shall be located on the top of the tank so that a bushing may be replaced without the need to reduce the oil level below the top of the windings.
- 7.6 Frame Ground:
 - 7.6.1 A frame ground bushing shall be provided.
 - 7.6.2 When there is more than one (1) frame to clamp separate cores, each frame shall have an insulated cable brought up to a location near the top of the tank and be connected together internally. This connection shall be removable, and shall be designed with captive hardware. The connection location shall be easily accessible from a manhole or handhole on the transformer cover and the location shall be clearly identified on the transformer nameplate and marked on the appropriate manhole or handhole cover.
 - 7.6.3 Frame ground bushings shall be separately grounded outside the main tank.
- 7.7 Audible Sound Level:
 - 7.7.1 The guaranteed sound level for operation at the rated voltage shall be described in the Specific Transformer Data Sheets in the Appendix

8 Windings and internal leads

- 8.1 All conductors shall be copper.
- 8.2 Winding Design:
 - 8.2.1 Self-supporting coil design is encouraged, but windings must still be fully supported back to the core.
 - 8.2.2 Circular disc and/or helical type windings shall be provided for all windings, including series transformer if provided.
 - 8.2.3 Rectangular winding design will only be accepted for preventive autotransformers for a reactance-type LTC.
 - 8.2.4 Layer type windings will be accepted only for regulating windings. When layer windings are used, the radial build shall be a minimum of 12 mm. Only one conductor in the radial direction is allowed unless CTC conductor is used.
 - 8.2.5 Spring or isostatic pressure (preferred) shall be applied during the winding sizing process.
 - 8.2.6 If CTC (continuously transposed conductor) is used, the following requirements shall be met:

- 8.2.6.1 When conductor insulation on CTC is cellulose, it shall be Weidmann (Dennison) paper. On strap conductor, at least the outside 2 layers of conductor insulation shall be Weidmann paper. The insulating paper shall be applied in either single or multiple strands in such a manner that 30% overlaps.
- 8.2.6.2 Brazes in CTC shall not be used unless the required conductor length exceeds the maximum available reel capacity. When required due to conductor length limitations, brazes shall be strand-to-strand, i.e. each strand shall be individually brazed and insulated separately.
- 8.2.6.3 Epoxy-bonded CTC shall not soften during any type of fault based on the shortcircuit temperature rise calculation in IEEE C57.12.00[™]. The allowable temperature for this condition is less than 140 °C.
- 8.2.6.4 When using CTC that is insulated with paper, the radial cooling duct shall be a minimum of 4.5 mm.
- 8.2.6.5 Formvar insulated conductors are not acceptable except with CTC.
- 8.2.7 The dielectric stress at any location in the core-and-coil assembly shall not exceed 2.65 kV RMS/mm with the transformer energized at 100% voltage on the maximum stress tap position. Applicable stresses include but are not limited to turn-to-turn, winding-to-winding, winding-to-ground, phase-to-phase and lead-to-lead.
- 8.2.8 Windings subject to inward radial buckling shall be designed to withstand "free" (unsupported) buckling in addition to "forced" (supported) buckling. The control of inward radial forces shall not depend on bracing to the core. The use of epoxy bonded CTC is required for windings subject to inward radial buckling. Short circuit calculations shall be based on an infinite bus. When layer windings are used, each layer shall be designed for "free" buckling independent of the other layers.
- 8.2.9 Where needed for pack-out, solid tapered insulating material shall be used in a disk or turn instead of duct-strip.
- 8.3 Winding and lead insulation:
 - 8.3.1 The winding insulation system shall be thermally upgraded to meet the operating conditions for 65°C rise.
 - 8.3.2 All cellulose winding insulation shall be Dennison paper insulation.
 - 8.3.3 All insulating materials that could come in contact with the winding conductors or leads shall have rounded edges.
 - 8.3.4 Excluding lead supports and clamping rings, all insulation material shall be thermally upgraded (suitable for continuous operation at 110°C).
 - 8.3.5 One-piece top and bottom clamping rings shall be used. There shall be no reduction in the thickness of the top clamping ring in the core window.
- 8.4 Lead supports:

- 8.4.1 All lead support distances shall be less than 24 inches. All leads shall be clamped to blocks secured by non-metallic bolts. Ties and tie-wraps shall not be used.
- 8.4.2 All connections shall be firmly supported with reasonable clearances between connections of unlike voltages. Sharp bends shall not be used in interties or terminal leads. Supports for insulated transformer leads shall have rounded edges, either from machining or cardboard angles, to prevent damage to cable insulation during normal movement in transportation or operation.
- 8.4.3 Openings in insulated tubing shall be flared or rounded smooth when used for entrances or exits of insulated leads run inside the tubing.
- 8.4.4 Internal non-metallic support structures provided for support of leads and other internal devices shall be bolted together using non metallic threaded rods with nuts at each end. Nuts shall be locked in place, either by disrupting threads, tying off threads or epoxying threads, so that nuts cannot come loose due to any amount of vibration or any amount of thermal expansion and contraction while still allowing for disassembly by the application of deliberate force on the nut.
- 8.5 Connections:
 - 8.5.1 Soldered connections shall not be used internal to the tank. Brazed connections are acceptable.
 - 8.5.2 Each internal bolted electrical connection shall use two bolts with Belleville washers. Split spring lock washers are not acceptable in the assembly of internal transformer components.

9 De-Energized Tap Changer (DETC)

- 9.1 An externally operated DETC shall be provided for the high voltage winding taps.
- 9.2 The DETC shall include tap positions as described in the Appendix section. All taps shall be full capacity taps.
- 9.3 A positive type position indicator shall be furnished, complete with provisions for padlocking the DETC in any on-tap position with padlocks having 3/8" shanks and 2" x 2" x 7/8" bodies. A suitable weather shield shall be provided over the padlock and positioning pin and shall be designed to eliminate the need for tools for access. Any exposed portion of the mechanism, such as a position indicator or geneva gear, shall also be furnished with a weather shield.
- 9.4 The DETC operating handle is to be readily accessible for operation without interference from adjacent parts.
- 9.5 All taps shall be rated for loading above maximum nameplate capabilities of the transformer as specified in Data Sheets.
- 9.6 All DETCs on a transformer shall be operated by a suitable single external manual handle device, conveniently and safely operable from the ground, with the handle no more than 3 to 5 feet above the tank base. Multiple DETC operating handles are not acceptable.
- 9.7 Any shaft penetration designs directly through the tank wall at a location below the top of the core/coil assembly shall have double sealing on the rotating shaft and on the mounting flange.
- 9.8 Under no conditions shall a sprocket and chain drive arrangement be acceptable for connecting the DETC assemblies on each phase to the common operating shaft.
- 9.9 DETCs shall be prevented from being left between taps and shall be prevented from moving off tap due to vibrations or bumping.
- 9.10 All tapered pins used in DETC assemblies shall be fully driven into the holes, slightly below the surface of the entrance side of the holes, and the entrance side of the holes deformed.

10 Tap changer for operation under load

- 10.1 Load Tap Changers (LTC's) shall be manufactured by Reinhausen and of sufficient capacity to satisfy the requirements in this specification.
- 10.2 Capabilities and Ratings:
 - 10.2.1 Load-tap changing equipment shall provide plus and minus 10% in-phase regulation of the low voltage winding in 32 steps of approximately 5/8% each. All voltages listed on the nameplate shall reflect the actual design voltages, rounded to the nearest 10 volts.
 - 10.2.2 All taps shall be full capacity taps.
 - 10.2.3 The tap changer is required to regulate the secondary voltage for a varying primary voltage on the transformer as well as for the increased voltage drop due to increased load on the transformer.

10.2.4 The transformer shall be capable of full MVA output should the LTC stall in any off-tap position.

- 10.2.5 The tap changer shall be capable of completing a tap change if a thru-fault occurs after a tap change has begun.
- 10.2.6 LTC's shall be capable of parallel operation with circulating currents not to exceed 20% of rated current.
- 10.2.7 All components of the transformer shall be capable of carrying maximum rated current at all tap positions.
- 10.2.8 Series load tap changer windings, if any, shall be so sized and arranged that they, or any of their associated leads, do not become the transformer hot spot or generate gasses if the transformer is operating at full buck at maximum current above nameplate capacity.
- 10.3 Tap changer operation:
 - 10.3.1 A mechanism for hand operation shall be provided.
 - 10.3.2 LTC drive motor shall include the following:
 - 10.3.2.1 A driving motor suitable for operation from the station service source described in the Appendix. 120 VAC motor is preferred. Motors rated 240 VAC or 208 VAC shall be capable of operating at either voltage.
 - 10.3.2.2 Suitable overload protection and motor starting contactors for the driving motor control.
 - 10.3.2.3 An ammeter to monitor the drive motor.
 - 10.3.2.4 Under-voltage relays sensing loss of power to the LTC motor and controls.
 - 10.3.3 Mechanical position indicator with provisions to show maximum raise and lower positions of the mechanism by means of manual reset indicators. The drag-hand reset device shall be located less than five feet above the base of the transformer. The dial-type indicator shall be configured so that the dial moves in the clockwise direction for tap changes in the raise direction (increasing LV voltage).
 - 10.3.4 Two operation counters; one will display total operations and the other will be resettable and will have an alarm contact for excessive operations. The number of operations for which the alarm contact closes shall be user-adjustable.
- 10.4 Tap changer controls:
 - 10.4.1 Beckwith LTC controls equipment shall be provided as follows:
 - M-2001D Tap Changer Control with Vacuum Fluorescent Display
 - M-2067B Adapter Panel
 - M-0115A Parallel Balancing Module

- M-0127A Over current Relay (circulating current), with auxiliary contacts for alarm indication.
- M-0169A (5/8.66 0.2 Amp) Auxiliary CT

- 10.4.2 Mode Selector Switch, ElectroSwitch Series 24, to select sequential or non-sequential mode of operation. (Operable from ground with doors open)
 - 10.4.2.1 Sequential Tap changer will continue changing taps as long as Raise-off-Lower switch is held in either position.
 - 10.4.2.2 Non-Sequential Tap changer will move only one step regardless how long Raiseoff-Lower switch is held in position. Control Switch must be returned to OFF position before OLTC will move to another tap.
- 10.4.3 Manual, Automatic and provisions for Remote control shall be provided as follows:
 - 10.4.3.1 "Raise-Lower" manual control switch shall be provided in the control cabinet for local control.
 - 10.4.3.2 "Remote-Automatic-Manual" switch shall be provided per sketch (SKT-DJW-1-05) See Appendix.
 - 10.4.3.3 There shall be provisions made for future remote control of load tap changing equipment.
- 10.4.4 Voltage Reduction Provisions. All transformers shall include provisions for two steps of voltage reduction (2-1/2% and 5%).
 - 10.4.4.1 120 VAC power supply provision for the Customer's radio receiver which will contain contacts for 2-1/2% and 5% voltage reduction.
 - 10.4.4.2 A three-position 43VR switch shall be provided for local initiation of voltage reduction. (The switch shall be labeled "2-1/2% Normal 5 %.")
 - 10.4.4.3 VR2.5 and VR5.0 Auxiliary Relays which will be picked up by appropriate contacts in either the radio receiver or the 43VR switch. The VR2.5 and VR5.0 Auxiliary Relays will have contacts connected to appropriate terminals of the "90" relay.
- 10.4.5 The LTC control shall include Line Drop Compensation. LTC current circuit grounds are to be grounded directly at the short-circuiting block of the current transformer only.
- 10.4.6 A potential source for the voltage regulating relay will be supplied by the Purchaser. The Seller shall provide a 1:1 isolating transformer to isolate this source from the LTC circuit.
- 10.4.7 Suitable test terminals for measuring regulated voltage shall be provided.
- 10.4.8 Test switches (States SMH, States MTS, or ABB FT-1) shall be provided for isolating voltage and current to the LTC controls. Current test switches shall be shorting type with test jack. Voltage test switches shall include test jacks.
- 10.4.9 Three limit switches, SPDT suitable for 0.5A at 125VDC as follows:
 - 10.4.9.1 One switch with the normally open (N.O.) contact closed only when OLTC is in ON TAP in the full raise position and the normally closed (N.C.) contact closed in all other positions.

- 10.4.9.2 One switch with the normally open (N.O.) contact closed only when OLTC is ON TAP in the full lower position and the normally closed (N.C.) contact closed in all other positions.
- 10.4.9.3 One switch with the normally open (N.O.) contact only closed when OLTC is ON TAP in the neutral position and the normally closed (N.C.) contact closed in all other positions. The NO contact shall be wired to the Beckwith M-2001D for use with the neutral position detection feature.
- 10.4.9.4 All contacts shall be wired out to terminal block in the control cabinet.
- 10.4.10LTC alarms: One common annunciator point on the transformer annunciator shall be provided to indicate any of the following:
 - 10.4.10.1 LTC "OFF-TAP".
 - 10.4.10.2 Vacuum problem, if applicable
 - 10.4.10.3 Excessive operations
 - 10.4.10.4 LTC fault pressure relay alarm
 - 10.4.10.5 M-2001D "Self-Test" alarm
 - 10.4.10.6 M-2001D actuation of Block Raise/Lower (user programmable alarm)
- 10.4.11 Provisions shall be made to block LTC operation by a normally closed contact of the Purchaser's transformer lockout relay.
- 10.4.12 Tap position indicator providing exact position, complete with an electrically operated synchro transmitter (Incon 1292) for remote exact position indication. Indicator shall not be mounted on cabinet cover but shall be visible through a weatherproof view port by a person of average height standing erect. The vendor shall also supply a tap position receiver (Incon 1250B) with the appropriate programming and scaling to function properly with the supplied tap position transmitter. The receiver shall be suitable for panel mounting and contain an integral transducer providing 0-1mA or 4-20 mA analog output and RS232 serial output for remote tap position indication to SCADA center. The vendor shall supply documentation showing the value of the analog output signal of the transducer and the corresponding tap position of the transformer.

10.5 Paralleling:

- 10.5.1 A circulating current paralleling scheme shall be used for parallel operation of the transformer's regulating equipment with a similar unit as described in the Specific Transformer Data Sheets in the Appendix. This scheme shall insure that the transformers are within two steps of each other while they are operating in parallel.
- 10.5.2 Equipment shall be installed to block operation of the load tap changing equipment in a direction which would increase circulating current for an abnormal condition.
- 10.5.3 Suitable current transformers shall be provided for line drop compensator operation and/or for input to a circulating current paralleling scheme. Phase(s) to be used for LDC CT's are identified on the Specific Transformer Data Sheet in the Appendix. Secondary leads shall be connected to terminal blocks in the CT cabinet. Auxiliary CT's (5:0.2 amp) shall be provided as necessary.
- 10.5.4 A 52Y (Interposing relay) with (2 NO and 2NC) contacts shall be provided for use by the Customer in the paralleling scheme.
- 10.5.5 Provisions shall be made to permit either phase-to-neutral or phase-to-phase voltage input along with corresponding CT connections.
- 10.5.6 A 32 step resistor (25 ohm, 3 watt resistor per step, 800 ohms total) shall be provided for use by the purchaser to indicate tap position, per Sketch SKRC1293.
- 10.6 LTC Accessories:
 - 10.6.1 Local Control Switch, ElectroSwitch Series 24, with pistol grip handle, spring return to OFF, for LTC controls. Switch shall be labeled Lower-OFF-Raise (Operable from ground with doors open).
 - 10.6.2 Necessary equipment to permit parallel operation with the transformers specified. This equipment shall include:
 - 10.6.2.1 An adjustable time delay relay, to start timing on operation of the circulating current relay.
 - 10.6.2.2 Current test facilities, (Superior, States SMH, States MTS, or ABB FT-1) for testing LDC current transformer and circulating current relay.
 - 10.6.2.3 An auxiliary relay used in conjunction with the Beckwith M-0127A, to block tap changer operation and transmit remote alarm on time out of the time delay relay. Alarm contact(s) shall be connected as required to the HIGH CIRCULATING CURRENT ALARM point on the local annunciator. Auxiliary relay shall have contacts rated for 125vDC. (No higher than 4 feet 6 inches above base of transformer)
 - 10.6.3 Pressure relief device, temperature indication equipment, and fault pressure relay per Section 12.4.

- 10.6.3.1 Pressure relief device shall be screened to prevent entrance of foreign objects and moisture into the compartment. Setting of the relief devices shall be as determined by the load tap changer manufacturer.
- 10.6.3.2 The LTC pressure relief alarm will be connected to an LTC PRESSURE RELIEF alarm point on the local annunciator.
- 10.6.3.3 Semaphore for LTC compartment shall be visible from the ground.
- 10.6.3.4 Discharge of pressure relief device(s) shall be baffled to control direction and extent of spray and to facilitate clean-up.
- 10.6.4 Lamp receptacle controlled by a door switch and located remote from control wires. Receptacle shall be for USA standard medium base lamps.
- 10.6.5 NEMA grounded convenience receptacle with GFI protection in the control cabinet.
- 10.6.6 Parts or components of the tap changer that will require periodic adjustment or replacement shall be built to ASTM Standards permitting the use of standard tools.
- 10.6.7 Space heater(s) with protective guard(s), located to prevent overheating wiring or equipment or accidental contact by personnel checking wiring.
- 10.6.8 Space heaters shall be uncontrolled and sized to maintain internal cabinet temperature at least 5°C above external ambient, with external ambient temperature as per Section 4, Service Conditions.
- 10.6.9 Multiple heaters safely distributed over bottom of control cabinet shall be provided if more than 250 watts (net) is required. To be controlled by 20A circuit breaker.
- 10.6.10 Rated voltage of space heaters shall be at least 67% higher than the applied voltage.
- 10.6.11 All LTC control wiring shall be stranded copper, #12 AWG minimum, with thermosetting 600V insulation, 90OC or higher, electrically, thermally and mechanically suitable for its environment and application. Flame, oil and heat resistant wiring with higher voltage thermosetting insulation or higher operating temperatures are acceptable without prior approval.
- 10.6.12A Non-GGCI outlet, see section 12.8.5.
- 10.6.13LTC compartments shall meet the following requirements:
 - 10.6.13.1 The oil system for OLTC shall be independent of and isolated from the main tank oil system. All barriers between OLTC compartment and main tank shall permit full vacuum filling of the main tank regardless of the status of the tap changer compartment.
 - 10.6.13.2 Tap changer shall be free-breathing with a suitable desiccant breather located approximately 5 feet from the transformer base for ease of replacement.
- 10.6.14 Each separate LTC oil-filled compartment shall have the following minimum accessories:

10.6.14.1 One - Upper vent connection with pipe cap.

- 10.6.14.2One Lower fill and drain valve with pipe plug.
- 10.6.14.3 Valve to have sampling valve located outside the disk of the main valve.
- 10.6.14.4 The valve shall be on the bottom of the compartment.
- 10.6.14.5 One Oil level indicator with high and low level alarm contacts.
- 10.6.14.6 All LTC level alarms will be connected to a single LTC OIL LEVEL alarm point on the local annunciator.
- 10.6.14.7 Indicators for all compartments shall be readily visible from a single location.
- 10.6.14.8 Each compartment of the tap changer shall have an RTD temperature sensing device mounted in a well. Extension leads shall be run in a weatherproof raceway system to the electronic temperature monitoring device in the cooling control cabinet.
- 10.6.14.9One Pressure relief device shall be provided for the common LTC compartment, Qualitrol #208 automatic reset type, with alarm contacts and readily visible semaphore. And baffle and discharge pipe.
- 10.6.15The power supply for the LTC motor shall be as specified in the Data Sheets in the Appendix. AC and DC auxiliary power for LTC motor and controls shall be routed from the cooling equipment control cabinet as separate branches.
- 10.6.16A hand crank shall be provided for operating the LTC for maintenance or due to a defective motor.
- 10.6.17 It shall not be necessary to take the transformer out of service to manually operate the LTC.
- 10.6.18 Interlocks shall be provided to de-energize motor while hand crank is in place for manual operation.
- 10.6.19Heavy duty limit switches shall be provided to cut off the LTC motor circuit and control circuit at the end of the desired travel.
- 10.6.20 Separate contacts shall be provided for the motor circuit and the control circuit. Limit switches shall not be located in any oil filled compartments.
- 10.6.21 Torque switches for motor and/or control circuit shutoff are not acceptable.
- 10.6.22LTC drive motor and controls may be in a common control cabinet. The control cabinet for OLTC drive motor and controls shall be separate from the control cabinet for transformer cooling controls, miscellaneous controls, alarms and CT lead terminations unless otherwise specified.
- 10.6.23 Each LTC control cabinet shall be weather proof, with hinged access doors as follows:

- 10.6.23.1 No door shall exceed 42 inches in width. Double doors are preferred on cabinets wider than 36 inches.
- 10.6.23.2 Locking facilities, suitable for padlocks with 3/8" shanks and 2" x 2" x 7/8" bodies, shall be provided.
- 10.6.23.3 Doors shall have suitable gaskets completely around each opening and a weather shield on the top horizontal surface.
- 10.6.23.4 Each door shall be equipped with a holding bar or other mechanism to securely hold the door open at least 110O from the cabinet against winds gusting to 25 miles per hour
- 10.6.24 The top of the LTC control cabinet shall not be more than six feet above the base of the transformer.
- 10.6.25 Exposed operating shafts between the LTC and the control cabinet shall be equipped with removable shrouds for personnel safety.
- 10.6.26 The following equipment shall be housed in all LTC control cabinets. No control or indicating devices shall be mounted on the outer cabinet doors.
- 10.6.27 Voltage test terminals to permit monitoring voltage regulating relay input voltage and to permit impressing external voltages for calibration and setting of voltage regulating relay. (Accessible from ground with doors open)
- 10.6.28 All control wiring shall terminate with insulated full ring lugs on one side of 600V, 25A (or higher), double row barrier type terminal blocks with screw terminals and captive links, GE type EB-25. Barrier spacing shall be sufficient to permit termination of #10 AWG wiring using Insulated Full Ring Terminal with Seamless Barrel or Braised Barrel.
- 10.6.29No more than two wires shall be terminated under any given screw terminal.
- 10.6.30 Manufacturer's wiring to terminal blocks intended for extension by Customer shall terminate on one row, with the other row kept clear of Manufacturer's wiring. The row used for Manufacturer's wiring and Customer's wiring shall be consistent on all terminal blocks in a vertical column, with rows arranged so Customer's cables may rise between two adjacent rows and fan out in each direction. There shall be a wiring extension to a connection box where plug/ receptacle type connectors shall be used for quick connection of wiring into modular substation.
- 10.6.31 All wiring associated with tripping, including lockout relays and initiating devices, shall be unfused.
- 10.6.32 All Manufacturer's LTC control wires shall be provided with indelible marker sleeves at each termination designating the location of the opposite end termination.
- 10.6.33 All wiring inside the LTC control cabinet shall be run in wire duct with snap on covers to permit easy tracing of circuits. Open wiring bundles with wraps are not acceptable.

- 10.6.34All components in the LTC control cabinet shall be capable of continuous operation with an air temperature inside the cabinet that is 10°C above the outdoor ambient temperature as specified in Section 4, Service Conditions.
- 10.6.35 Any load tap changer shall be capable of successfully completing a tap changing operation without damage if an external short circuit occurs while the load tap changer is changing taps.
- 10.6.36Line drop compensator, control relays, time delay relays and facilities for readily reversing polarity of reactance compensation. See Data Sheets for specific transformer.

11 Tank construction

- 11.1 Temporary internal shipping braces shall not be used.
- 11.2 Structural Loading Requirements:
 - 11.2.1 Equipment provided under this specification shall be analyzed and found to be functional for the physical loading conditions described below. The equipment shall be designed so that there will be neither damage nor loss of function during and after the loading conditions delineated below. In addition, equipment shall maintain correct operational state during these conditions.
 - 11.2.2 The manufacturer/supplier is responsible for assuring that their analytical methodology is consistent with industry standards and guidelines listed below and that the results are reported accurately to the purchaser.
 - 11.2.3 The manufacturer's analysis shall consider the higher of seismic load or wind load to act concurrently with the other applicable loading conditions as follows. Design criteria shall be clearly noted on the outline drawing.
 - 11.2.3.1 **Wind Load:** The equipment shall be analyzed to the appropriate state building code for a wind load 120 mph applied to the component's entire projected area normal to the wind.
 - 11.2.3.2 **Seismic Load:** Seismic analysis of equipment shall be performed utilizing the Static Analysis Method as described in IEEE Standard 693-2005. A horizontal seismic coefficient of 0.5g and a vertical seismic coefficient of 0.4g shall be applied to the component's center of gravity and the resulting forces determined.

Appendages such as electrical bushings, radiators, and pipes shall be designed for twice the horizontal and vertical seismic loads.

- 11.2.3.3 **Dead Load:** Consider the weight effects of the equipment including all ancillary equipment and fluids.
- 11.2.3.4 **Operating Load:** Equipment mechanical operating loads shall be evaluated for impact on anchorage and other support points. If operating loads are negligible then a statement shall be clearly noted on the drawings.
- 11.2.3.5 **Terminal Connections:** Allowable loads for terminal connections shall be determined by the manufacturer for the lug design shown on their equipment drawing. Allowable loads shall be noted on the drawings.
- 11.3 Transformer tanks shall be of welded steel construction.
- 11.4 The core clamp shall be isolated from the tank.
- 11.5 Tank corners shall be bent with seams welded inside and outside at least six inches from the corner.
- 11.6 A leak test of the welded joints at the factory is required before the transformer is accepted for shipment.

11.7 Both the tank and cover shall be provided with lifting lugs.

- 11.8 The tank shall be provided with jacking lugs with stenciled identification. Minimum height of jacking lugs shall be 12" above base. Minimum projection of the jacking lugs shall be 10" from the tank wall.
- 11.9 The base shall be furnished without wheels, designed for rolling or skidding parallel to either center line. If the transformer does not have a structural steel base and requires suitable shims or blocking for base ventilation, the Seller shall be responsible for providing the necessary material.
- 11.10 All manhole, bushing, and pressure relief device openings in the tank cover shall utilize raised flanges with thru-bolts or blind tapped holes. Studs welded to the tank cover will not be accepted.
- 11.11 All bushing adapters shall be equipped with air bleeder valves when a conservator-type oil preservation system is specified. These valves shall be used to purge air from the main tank during oil filling.
- 11.12 Manholes:
 - 11.12.1 There shall be two or more 24-inch manholes in the top of the transformer to facilitate the removal and installation of bushings and current transformers (CTs) and to provide access to terminal boards (when used) without disturbing the leads, un-tanking the transformer, removing the cover, or removing radiators. Manhole covers shall include lifting handles.
 - 11.12.2Covers and flanges shall be sufficiently stiff to prevent gas or oil leakages after bolts are tightened.
 - 11.12.3 Sufficient manholes shall be provided on the tank cover of core form transformers to permit access to each side of the core and coil assembly, with at least one on each side of the core and coil.
 - 11.12.4 Manhole locations shall permit the proper use of confined space retrieval equipment for personnel inside the tank.
 - 11.12.5 All manhole covers, whether on top or walls, shall be on raised flanges. Covers for maintenance or field assembly access shall be secured with nuts, bolts and gaskets, with those on walls having two concentric gaskets in separate grooves.
 - 11.12.6 Any and all wall access provisions are subject to specific approval by the Engineer during the bid evaluation process, regardless of past history of acceptance.
 - 11.12.7 Covers for wall mounted access points shall be equipped with hinges and handles regardless of weight.
 - 11.12.8Covers of access points used solely for factory assembly and testing shall be sealed using at least two full passes with no oil in the tank during welding.

- 11.13 The tank shall be mechanically strong and designed for both full vacuum filling and 10 psig positive pressure (or 25% above maximum operating pressure, whichever is greater), with all joints and connections full seam welded externally to eliminate possible oil leaks.
- 11.14 At no time during normal operation of the transformer, up to and including full loading above nameplate capabilities, shall the:
 - 11.14.1 Exterior surface of the tank, or any appurtenances, become hot enough to cause injury to personnel upon momentary contact or to cause personnel to react in an unsafe manner upon such contact.
 - 11.14.2 Interior surface of the tank, or any interior metallic members, become hot enough to generate gas in the insulating oil.
- 11.15 Sufficient clearances shall be provided between the core and coil assembly and the tank walls and cover of core form transformers to permit comfortable internal inspection of the transformer by an average sized individual.
- 11.16 Lifting, moving and jacking facilities shall be provided in accordance with ANSI C57.12.10 and for any covers over 40 pounds. Covers under 40 pounds shall be equipped with handles to facilitate controlled removal.
- 11.17 All vents on top of transformer tanks shall be sealed using pipe caps. Pipe plugs are not acceptable.
- 11.18 Fall protection shall include two Winsafe weld-on base plates, model number GM135.
- 11.19 The top of the main tank shall be painted with non-slip coarse grit paint compatible with the Manufacturers normal finish. Grit paint shall be on the tank top only and not on raised flanges or covers.
- 11.20 All valves, pipes or other extensions shall be strong enough to support a 250 pound person or shall be provided with a guard that can support a 250 pound person. Guards shall not restrict maintenance or operating access to the equipment being guarded.
- 11.21 Bolts, nuts, screws, etc., shall meet ANSI Standard B1.1 and shall be corrosion proof. Bolt heads and nuts shall be hexagonal.
- 11.22 All hardware exposed to the weather shall be stainless steel (nuts, bolts, hinges, etc.).

12 Auxiliary Equipment

12.1 Bushings:

- 12.1.1 All bushings shall be Resin Impregnated Paper (RIP) bushings oil-free dry and clean technology.
- 12.1.2 All terminal bushings (unless otherwise noted on the Specific Transformer Data Sheet in the Appendix) shall be located on the tank cover and shall be in accordance with IEEE Standards where applicable.

- 12.1.3 The current rating of each bushing shall be equal to or greater than the current it will carry at the maximum forced-cooled rating and overload rating. Additionally, the current rating of each neutral bushing shall not be less than the current rating of the associated line bushings. The H0X0 bushing, when required, shall be rated to sustain the maximum operating current of the common winding.
- 12.1.4 Bushing leads shall be accessible from the bushing cover. Accessibility to leads shall not require personnel to enter the transformer tank.
- 12.1.5 A draw-lead connection is required for all bushings whenever possible. In cases where the transformer winding leads are bolted to the bottom of the bushings, two-bolt connections shall be used; single-bolt connections are not acceptable.
- 12.1.6 Approved suppliers of bushings are: Trench, LAPP, Pcore Electric, AREVA, Siemens and ABB.
- 12.1.7 Bushing outline drawings with stud sizes identified shall be submitted with transformer approval drawings.
- 12.1.8 4-hole NEMA bushing terminal connectors shall be supplied for each bushing. Connectors shall be tinned copper-bronze, and finished on both sides. Cut sheets shall be provided showing materials, dimensions and current rating of terminal connectors.
- 12.2 Bushings for Buried Y-Terminals
 - 12.2.1 Where a buried delta tertiary is specified, the corner of the delta shall be brought out through bushings. The corner of the delta shall be completed externally and grounded through an external connection.
 - 12.2.2 The two winding terminals at one corner of the tertiary delta shall be separately brought through 15 kV bushings mounted on the tank cover.
 - 12.2.3 Removable straps shall be furnished to connect the external bushing terminals together and to the tank.
 - 12.2.4 The bushings shall be located and labeled to avoid confusion with other bushings, and shall be protected with a removable, weatherproof metal cover.
 - 12.2.5 An instruction plate shall be furnished and mounted near these bushings, specifying that the external bushing terminals must be connected together, and to the tank, whenever the transformer is energized. The same instructions shall be shown on the main transformer nameplate.
- 12.3 Surge Arresters:
 - 12.3.1 Arresters shall be supplied in accordance with the following requirements and per the below approved arrester list.
 - 12.3.1.1 Station Class
 - 12.3.1.2 Silicone Polymer housing

12.3.1.3 NEMA 4 hole flat pad terminals

- 12.3.1.4 Metal Oxide Varistor (MOV)
- 12.3.1.5 Ground Terminal
- 12.3.1.6 IEEE Nameplate.
- 12.3.2 Mounting:
 - 12.3.2.1 Removable supports shall be provided for the mounting of arresters.
 - 12.3.2.2 Minimum metal-to-metal clearance shall be at least 6" greater than that specified for the associated bushing, including any corona rings within the metal-to-metal criteria.
 - 12.3.2.3 A mounting bracket shall be provided for the H0 arrester, when required on a Wye-Wye transformer.
- 12.3.3 Ground connections of at least 1" x ¼" copper bar shall be provided from the surge arresters to the base of the transformer tank for connections to the station ground grid by the Customer. Arrester mounting details shall not be used as part of the ground path
- 12.3.4 Ground bus design shall permit the installation of leakage current monitors and/or discharge counters by the Customer if so desired. Design shall be based on one monitor or counter per three phase set unless otherwise specified. All proposals shall include an adder for insulating sub bases as required
- 12.3.5 Approved suppliers of arresters are: Joslyn, Hubbel, Cooper Power Systems, General Electric, Siemens and ABB.
- 12.4 Instrumentation and Monitoring Equipment:
 - 12.4.1 Messko oil level indicators with alarm contacts shall be provided for the Main Tank and LTC.
 - 12.4.2 A sudden pressure relay wired to one auxiliary relay in the cooling control cabinet shall be provided on each transformer. Sudden pressure relay mount will include a fulldiameter ball valve to allow isolation from the main tank. Buchholz relays are not acceptable for this application. If a Buchholz relay is provided for gas collection a separate relay shall be provided for sudden pressure and the rapid rise contact of the Buchholz relay shall not be wired to any alarms or trip devices.
 - 12.4.2.1 A Qualitrol type 900-004-03 Sudden Pressure Relay installed on a separate valve on the main tank. In addition, a 909-300-01 seal-in relay shall be provided with contacts for trip and alarm, as well as additional contacts as detailed below.
 - 12.4.2.2 An auxiliary relay shall be provided as necessary to provide additional output contacts.
 - 12.4.2.3 One additional auxiliary relay contact shall be wired to terminals for external use by the Customer. Contacts shall not share any terminals. One contact shall be

used for a remote indicating light to indicate that the seal-in relay must be reset before the transformer lockout relay can be reset.

- 12.4.3 An LTC Fault Pressure Relay (Pressure Switch) with alarm contacts shall be provided to annunciate high pressure in the LTC.
- 12.4.4 Qualitrol Main Tank pressure/vacuum gauge.
- 12.4.5 For transformers with a Nitrogen oil preservation system, a nitrogen supply cylinder pressure gauge shall be provided.
- 12.4.6 For transformers with a conservator oil preservation system, a gas detection system shall be provided, consisting of a gas detector relay which will accumulate any released gases from several collection points located on the main tank cover.
- 12.4.7 A Qualitrol Model #509ITM-300 electronic temperature monitor (ETM) shall be provided with the following options:
 - 12.4.7.1 This device shall be equipped for the following:
 - 12.4.7.2 125VDC power supply.
 - 12.4.7.3 Three input channels. The inputs shall be the leads from the RTD sensors mounted in thermowells on the main tank. These channels shall be used to monitor:
 - 12.4.7.3.1 The winding temperature RTD sensor.
 - 12.4.7.3.2 The top oil temperature RTD sensor.
 - 12.4.7.3.3 LTC oil temperature RTD sensor.
 - 12.4.7.4 Four 0-1mA/4-20mA analog output channels to provide winding temperature, top oil temperature, and the differential temperature of the main tank oil and the LTC oil to the SCADA center.
 - 12.4.7.5 One set of normally open alarm contacts wired to the HIGH TOP OIL TEMPERATURE annunciator point.
 - 12.4.7.6 One set of normally open alarm contacts wired to the HIGH WINDING TEMPERATURE annunciator point.
 - 12.4.7.7 One set of alarm contacts wired to the HIGH LTC DIFFERENTIAL TEMPERATURE annunciator point.
 - 12.4.7.8 Two set of contacts [change state on winding temperature setpoints] shall be wired for cooling control. One set of contacts shall be arranged in a fail-safe design so that if the temperature monitoring system fails the contacts will activate the cooling system.
 - 12.4.7.9 The contacts shall be wired for fail-safe control of the cooling system.
 - 12.4.7.10Two sets of contacts [one set for winding temperature and one set for oil temperature] shall be wired to terminal blocks for extension by the Customer. These are the TRIP contacts on the Qualitrol device.

12.4.7.11 The temperature monitor shall be mounted on a swing panel in the control cabinet.

- 12.4.7.12 The control cabinet that houses the temperature monitor shall be equipped so that the oil and winding temperatures can be read from the local display monitor without the need to open the control cabinet door.
- 12.4.7.13 This monitor/signal conditioner shall provide a 0-1mA analog output current that is proportional to the differential temperature of the main tank oil and the LTC oil.
- 12.4.7.14 Three RTD's shall be provided on each transformer, one complete with load bias heaters and associated auxiliary current transformer (on the hottest phase), to simulate the winding "hot spot" temperature, one to measure transformer top oil temperature and one to measure LTC top oil temperature. Each RTD is to be mounted in a dedicated thermowell. Extension leads shall be run in a weatherproof raceway system to the control cabinet that houses the temperature monitoring equipment when required in Data Sheets in the Appendix.
- 12.4.7.15 The winding hot spot temperature simulation, main tank top oil temperature measurement, and LTC oil temperature measurement shall be connected to the Qualitrol Model #509ITM-300 Electronic Temperature Monitor when required in Data Sheets in the Appendix.
- 12.4.7.16 All RTD leads between the probes shall be protected in flexible or rigid conduits.
- 12.5 When the Qualitrol 509 ETM is specified, one Messko "dial-type" winding temperature indicator shall be provided for backup indication in the event that the ETM is out of service.
- 12.6 Cooling Equipment:
 - 12.6.1 The transformer cooling system shall consist of the necessary radiators, fans, and piping, complete with automatic control equipment for operation from the temperature devices as described above.
 - 12.6.2 The transformer cooling equipment shall be arranged to provide a uniform distribution of cooling within the transformer with either or both stages in operation.
 - 12.6.3 Fan Requirements:
 - 12.6.3.1 Fan Manufacturer shall be Krenz.
 - 12.6.3.2 Fan shall be low velocity type for minimum noise operation.
 - 12.6.3.3 Fan motors shall be single phase. Fan Motors rated 240 VAC or 208 VAC shall be capable of operating at either voltage.
 - 12.6.3.4 Fan motors shall be designed for outdoor use with coated rotors and stators to prevent moisture damage. Fan motors shall include appropriate drain plugs per OEM design to allow drainage of condensation. Plugs shall be installed or removed as appropriate during shipment if fan orientation during shipment is not the same as normal in-service orientation, and warning tags shall be attached during shipment to alert installation personnel as to proper plug configuration after assembly.

- 12.6.3.5 Fans supplied with the transformer shall be designed with guards having a mesh spacing of 1/2" or less to meet OSHA requirements.
- 12.6.3.6 Refer to the Data Sheets for available cooling equipment power supplies.
- 12.6.3.7 Each fan motor shall have thermal overloads with readily visible and accessible reset buttons. Molded case motor circuit protector (MCP) circuit breakers in the control cabinet, sized for the motors, may be substituted for integral thermal overloads provided each motor has a dedicated MCP.
- 12.6.3.8 Cable connections to fans shall be disconnectable using weatherproof environmental connectors.
- 12.6.3.9 Exposed cable lengths shall be kept to a minimum. Coils of exposed cable are not acceptable and the Manufacturer shall be back charged any field costs associated with shortening or protecting cables.
- 12.6.3.10 Receptacles shall be equipped with captive safety caps to cover and seal the receptacles when not in use.
- 12.6.3.11 Receptacles and plugs shall have threaded environmental collars to prevent accidental separation of plug from receptacle.
- 12.6.3.12 Connectors shall be equipped with wire mesh strain relief grips, preferably at each end, to prevent cables from being separated from connectors if accidentally or intentionally pulled.
- 12.6.4 Cooling Controls:
 - 12.6.4.1 ON/OFF/AUTO selector switch shall be provided for each fan circuit.
 - 12.6.4.2 Lead fan bank selector switch shall be provided.
 - 12.6.4.3 Provision shall be made to shut down the cooling system using a normally closed contact from the Purchaser's transformer protective relaying scheme.
 - 12.6.4.4 Time delay under-voltage relays shall be provided per Section 12.9, Annunciator.
 - 12.6.4.5 Circuit breakers shall be provided for each fan circuit.
 - 12.6.4.6 The Manufacturer shall balance the AC power supply on branches to each cooling stage and to the load tap changer where one is specified.
 - 12.6.4.7 Undervoltage relays shall be provided on each bank to indicate loss of any cooling power supply. Alarm contacts shall be connected to the LOSS OF 1ST STAGE COOLING alarm point or the LOSS OF 2ND STAGE COOLING alarm point as appropriate.
 - 12.6.4.8 The master contactor for each stage of cooling shall have two auxiliary contacts, one normally closed with time delay on drop-out wired through a temperature contact to provide an alarm if the contactor drops out while the controls are calling for the contactor to be picked up and one normally closed instantaneous wired to

terminal blocks for Customer's remote position indication. Alarm contacts shall be connected to the LOSS OF 1ST STAGE COOLING alarm point or the LOSS OF 2ND STAGE COOLING alarm point as appropriate.

- 12.6.4.9 Construction details for the cooling equipment control compartment shall be similar to the load tap changer control compartment and shall include:
 - 12.6.4.9.1 Lamp receptacle controlled by a door switch and located remote from control wires. Receptacle shall be for USA standard medium base lamps.
 - 12.6.4.9.2 Space heater(s) with protective guard(s), located to prevent overheating either wiring or equipment. Space heater shall be uncontrolled and sized to maintain internal cabinet temperature at least 5°C above the external ambient temperature as specified in Section 4, Service Conditions. Multiple heaters distributed over bottom of control cabinet shall be provided if more than 250 watts (net) is required. Voltage rating of space heaters shall be at least 67% higher than the applied voltage.
 - 12.6.4.9.3 Two 20 Amp convenience receptacles, both visible from front and accessible from ground with door open. Receptacles without ground fault protection shall have provisions to restrict use to authorized personnel only.
 - 12.6.4.9.4 Circuit breakers to be used for operation of convenience receptacles. Must be visible from front and accessible from ground with door open.
- 12.6.5 Radiators:
 - 12.6.5.1 The design and construction of the radiators shall be such as to eliminate pockets where moisture can accumulate or which can prevent application of a continuous film of paint.
 - 12.6.5.2 Radiators shall have the necessary piping, fittings, valves, drains, and bleeder connections so that individual radiators may be removed and replaced with the transformer in service.
 - 12.6.5.3 Radiators shall be connected to the main tank through flange mountings with shut off valves at the top and bottom to permit shut-off of oil from the main tank for removal or installation of the coolers. Valves shall be designed to withstand maximum differential forces that can be applied during normal vacuum type oil filling operations.
 - 12.6.5.4 The radiators shall have solid steel plugs provided at the top and ball type drain valves at the bottom shipped with solid steel plugs.
 - 12.6.5.5 All radiators shall be galvanized and shall use plate type radiators.
 - 12.6.5.6 All radiators shall be flushed out prior to shipment. Pipe caps shall be provided at the top and pipe plugs at the bottom of each cooler to permit field flushing when desired.
 - 12.6.5.7 The oil flow pattern to and from the coolers and through the transformer coils shall be designed to be free of turbulence and shall not cause impinging of oil on any part of the solid insulation system.
 - 12.6.5.8 Radiators shall be designed to permit removal and installation without additional special bracing.

12.6.5.9 Refer to the Data Sheets for unusual service conditions that can affect radiator efficiency during the life of the transformer.

- 12.7 Control cabinet and wiring:
 - 12.7.1 Station service supply:
 - 12.7.1.1 Available station service will be either 120/240 VAC single phase, 120/240 VAC delta three-phase, or 120/208Y VAC three-phase. (Refer to the Specific Transformer Data Sheets for station service voltage requirements.)
 - 12.7.1.2 Motors rated 240 VAC or 208 VAC shall be single phase and shall be capable of operating at either 240 VAC or 208 VAC.
 - 12.7.1.3 All Under-voltage relays shall be single phase. Under-voltage relays connected line-to-line shall be capable of being adjusted for use on 208 VAC or 240 VAC, (i.e. dropout shall be adjustable from approximately 150 VAC to 200 VAC).
 - 12.7.1.4 A separate heavy-duty, four point terminal block for the Customer's incoming #1/0 minimum station service cables shall be provided in control cabinet.
 - 12.7.1.5 Total KVA demand for all auxiliaries shall be calculated and identified on the auxiliary power schematic.
 - 12.7.1.6 All equipment shall operate correctly, without overheating or loss of service life, when supply voltage is within ±10% nominal voltage or within specified range.
 - 12.7.1.7 Maximum nameplate rating of any equipment connected to a 208V supply shall be 220V. No equipment rated 230V or 240V is acceptable, except when the equipment is rated for the full range of 208V-240V.
 - 12.7.1.8 AC auxiliary equipment shall ride out momentary outages not exceeding 30 cycles and voltage sags to 70% for 120 cycles.
 - 12.7.1.9 The Customer's AC and DC power supplies shall be terminated on heavy duty terminal blocks in the Cooling Control Cabinet. Customer's wiring shall be sized for the load, subject to a #6 AWG minimum conductor for the AC power supply and #10 AWG minimum conductor for the DC power supply.
 - 12.7.2 Control and Wiring:
 - 12.7.2.1 All external control wiring to accessories, current transformer junction boxes, etc., shall be run in weatherproof raceway systems to either control cabinet as required for local control connections and the Customer's connections. Raceway systems that fill with water during normal use will be remedied at the Manufacturer's expense.
 - 12.7.2.2 Tank bracing is not to be used as a raceway for any control wiring.
 - 12.7.2.3 Flexible conduits or armored cables between devices and rigid conduits or tank bracing shall be weatherproof and their lengths as short as possible and no longer

than 3 feet. Loose ends of flexible connections ending in tank bracing shall be sealed against entry of moisture until field connections are made.

- 12.7.2.4 Intermediate terminal blocks between external devices and the control cabinets shall be barrier type. No splices shall be used.
- 12.7.2.5 Cabinet bottoms shall have ample space for the entrance of the Customer's conduits. In general, two 3 inch IPS conduits will enter the OLTC control cabinet and three 3 inch IPS conduits will enter the cooling equipment control cabinet.
- 12.7.2.6 Terminal blocks shall be made of phenolic plastic with captive screws.
- 12.7.2.7 All control wiring, with the exception of CT and VT secondary leads and sudden pressure trip leads, shall be stranded copper, #12 AWG minimum, with oil resistant thermosetting 600V insulation, 90°C or higher, electrically, thermally and mechanically suitable for its application. Flame, oil and heat resistant wiring with higher voltage insulation or higher operating temperatures are acceptable.
- 12.7.2.8 All wiring inside control cabinet shall be run in wire duct with snap on covers to permit easy tracing of circuits.
- 12.7.2.9 All control wiring shall terminate with insulated full ring lugs on one side of 600V, 25A (or higher), double row barrier type terminal blocks with screw terminals and captive links, GE type EB-25. Barrier spacing shall be sufficient to permit termination of #10 AWG wiring using Insulated Full Ring Terminal with Seamless Barrel or Braised Barrel.
- 12.7.2.10No more than two wires shall be terminated under any given screw terminal.
- 12.7.2.11 Manufacturer's wiring to terminal blocks intended for extension by Customer shall terminate on one row, with the other row kept clear of Manufacturer's wiring. The row used for Manufacturer's wiring and Customer's wiring shall be consistent on all terminal blocks in a vertical column, with rows alternating every other vertical column so Customer's cables may rise between two adjacent rows and fan in each direction.
- 12.7.2.12 All Manufacturer's wires shall be provided with indelible marker sleeves at each termination designating the location of the opposite end termination.
- 12.7.2.13 All wiring in the control cabinet shall be run in wire duct with snap on covers to permit easy tracing of circuits.
- 12.7.2.14 External wiring that is not in conduit shall be type SOW.
- 12.7.2.15 All relays, relay terminals, and terminal blocks shall be easily accessible even if the installation of a hinged door or a hinged panel is required. Control devices shall not be more than five (5) feet above the transformer base.
- 12.7.2.16 All unused relay contacts provided for the Customer shall be wired to terminal blocks and clearly identified in the control cabinet. At least 20% of the terminal points shall be provided as spares and evenly distributed among the occupied terminal points.

12.7.2.17 All relay and control devices shall be identified by engraved nameplates.

- 12.8 Control Cabinet Requirements:
 - 12.8.1 The control cabinet shall be of weather-proof construction with dip edge over hanging cabinet doors.
 - 12.8.2 Cabinet door to have provisions for a padlock.
 - 12.8.3 Each door shall be equipped with a holding bar or other mechanism to securely hold the door open at least 110° from the cabinet against winds gusting to 25 miles per hour.
 - 12.8.4 Lamp receptacle controlled by a door switch and located remote from control wires. Receptacle shall be for USA standard medium base lamps. 100W equivalent LED bulb to be supplied.
 - 12.8.5 One (1) 20 Amp, 120 VAC, single phase, wire grounded duplex convenience receptacle (GFI protected) shall be provided in the control cabinet.
 - 12.8.6 Weather-shielded, screened breather holes shall be furnished at the top and bottom of the cabinet.
 - 12.8.7 The bottom of the control cabinet shall have a removable plate suitable for the Customer's conduit connections. The removable plate shall be 8" x 20" or larger. The dimensions and centerline location of this plate shall be clearly shown on the outline drawing.
- 12.9 Annunciator:
 - 12.9.1 Two SEL 2533 annunciators (total of 20 alarm points), part # 253301213A0A3X0, shall be provided in the control cabinet to indicate the transformer alarms. The annunciator indicator lights shall be visible from outside the cabinet.
 - 12.9.2 Alarm points shell be wired such that device contacts are open during normal operation (closed on alarm condition).
 - 12.9.3 A 52X interposing relay for breaker position shall be provided with 2 NO and 2NC contacts. This relay will be used in blocking "Loss of Voltage" alarms when the transformer's breaker is open.
 - 12.9.4 The annunciator shall be suitable for operation on the Customer's station DC supply, as specified in the Appendix. All DC connections shall be ungrounded.
 - 12.9.5 The following alarm points shall be provided. (Bulleted items shall be grouped together for a common annunciator point.)
 - 12.9.5.1 Low Oil Level Main Tank
 - 12.9.5.2 Low Oil Level LTC
 - 12.9.5.3 High Oil Level- LTC
12.9.5.4 LTC Trouble:

- LTC "OFF-TAP".
- Vacuum problem, if applicable
- Excessive Operations (Active)
- LTC Fault Pressure Relay alarm
- 2001D self-test and block raise/lower
- 12.9.5.5 Nitrogen System Problem OR Conservator System Problem
 - Main Tank High Pressure
 Gas Accumulator Relay
 - Main Tank Low Pressure
 - Low Cylinder Pressure
- 12.9.5.6 Operation of Pressure Relief for main tank
- 12.9.5.7 Operation of Pressure relief for LTC
- 12.9.5.8 Loss of LTC Control Power
 - Loss of Voltage to LTC control circuit
 - Loss of Voltage to LTC drive motor

- 12.9.5.9 Loss of cooling control power
- 12.9.5.10 Loss of power to Fan Bank A
- 12.9.5.11 Loss of power to Fan Bank B
- 12.9.5.12 High Top Oil Temperature
- 12.9.5.13 High Winding Temperature
- 12.9.5.14 Hi Differential Temperature (LTC to Main Tank)
- 12.9.5.15 Electronic Temperature Monitor System Trouble
- 12.9.5.16 Gas Monitor HI Alarm
- 12.9.5.17 Gas Monitor HI-HI Alarm
- 12.9.5.18 Gas Monitor General Alarm
- 12.9.5.19 Main Tank Sudden Pressure Relay
- 12.9.5.20 Excessive Circulating Current
- 12.9.6 The above annunciator requirements do not preclude the installation of any additional standard accessories or alarm devices normally provided by the Seller.
- 12.9.7 The Manufacturer shall provide undervoltage relays on each phase of the AC power supply and connect the paralleled alarm contacts to the LOSS OF AUXILIARY POWER point on the annunciator.
- 12.10 Valves:
 - 12.10.1 All valves on the transformer shall be ball valves. Radiator isolation valves may be "Butterfly" or "flapper" type.
 - 12.10.2 "Butterfly" or "flapper" type valves used for radiator isolation shall include nitrile gaskets to provide leak-free isolation.
 - 12.10.3 Radiator isolation valves shall be provided at the top and bottom of each radiator, and shall be made of steel. Cast aluminum valves are not acceptable.
 - 12.10.4 When pumps are provided, they shall include isolation valves.
 - 12.10.5The transformer main tank shall be fitted with a 2-inch oil drain valve, complete with sampling valve located on the discharge side of the drain valve.
 - 12.10.6A 2" Upper filter press valve shall be installed on the main tank the same tank wall as the drain valve. The upper filter press valve will be used for filling of the transformer up to a rate of 40 gpm. A deflection plate internal to tank shall be provided as necessary.

- 12.10.7The LTC shall include a 2" fill valve and a 2" drain valve. The drain valve shall also include a sampling valve. LTC fill and drain valves shall be ball valves.
- 12.10.8A 1.5 inch ball valve shall be provided for a future installation of a gas-in-oil monitor. The valve shall be located in a good flow area for representative sampling. The valve shall be located within 6 feet of the control cabinet. The valve shall be located approximately 3 feet above the tank drain valve to permit installation/removal without the need to deenergize the transformer and also to prevent moisture intrusion due to snow.
- 12.10.9Conservator isolation valves. If a conservator is provided with the transformer, the conservator shall be capable of being isolated via a manually-operated valve. This valve shall have a mechanical position indicator on the valve.
- 12.10.10 All valves shall be flange type, with companion flanges welded directly to the tank. Nipples between the companion flange and the tank will not be allowed. Free end of valves may be flanged or female taper threaded as appropriate for the application or unless otherwise specified.
- 12.10.11 Oil drain valve, at least 2 inch, with non-ferrous metallic plug and with a 3/8" sampling valve located between the main valve and the plug. Bottom of drain valve inlet shall be at least tangent with, if not lower than, the tank bottom. Please note that this is more stringent than, and supersedes, ANSI C57.12.00.
- 12.10.12 Lower filter valve, at least 2 inch, for oil filling, with non-ferrous metallic plug. Lower filter valve may be dual function with oil drain valve.
- 12.10.13 Upper filter valve, at least 2 inch, with non-ferrous metallic plug if wall mounted or with gasketed blind flange if top mounted.
- 12.10.14 Oil sampling valve for top oil. Oil sampling valve may be incorporated in wall mounted upper filter valve between main valve and plug. Upper and lower sample valves shall be designed to permit the installation of tygon tubing for use as a level indicator during transformer filling.
- 12.10.15 Upper vacuum valve, at least 4 inch, with non-ferrous metallic plug if wall mounted or with gasketed blind flange if top mounted. Valve shall be diagonally opposite the filter valve if top mounted or on the opposite wall.
- 12.11 Bushing Current Transformers:
 - 12.11.1 Except where otherwise specified, each terminal bushing, including neutral, shall be equipped with bushing-type current transformers that meet the following requirements:
 - 12.11.1.1 All CT's shall have a continuous thermal current rating factor (RF) of 2 or higher. The thermal factor requirement shall be met during all loading requirements including planned overload.
 - 12.11.1.2 Multi-ratio (MR) CT's shall have 5 leads and fully distributed windings.
 - 12.11.1.3 All CT secondaries shall be rated 5 amperes with a continuous thermal rating of 10 amperes on all taps.

- 12.11.1.4 CTs shall conform to the latest IEEE Standard for 5-lead, multi-ratio current transformers.
- 12.11.1.5 Multi-ratio CTs supplied with the transformer for relay purposes shall have a metering accuracy of 0.3% up to B2.0 when at the full tap winding.
- 12.11.1.6 Single-ratio (SR) CTs supplied with the transformer for metering purposes shall have an accuracy of 0.3% up to B2.0.
- 12.11.1.7 See the Appendix for the number of CTs on each bushing and their ratios.

12.11.2CT wiring

- 12.11.2.1 All secondary wiring for CTs shall be at least #10 AWG stranded copper with oil resistant, thermosetting 600V insulation, 90°C or higher, electrically, thermally and mechanically suitable for its application. Flame, oil and heat resistant wiring with higher voltage insulation or higher operating temperatures are acceptable.
- 12.11.2.2 The five leads of each CT shall be wired to their own 6-point short-circuiting type terminal block, General Electric Type EB-27.
- 12.11.2.3 All CT secondary leads shall be brought out to an external junction box with stud, nut and lockwasher connections. All CT secondary leads shall be continuous except at the external junction box. No internal or external splices shall be allowed. Split lockwashers are not acceptable. Molded type junction blocks using splices are not acceptable. Note that this applies to all CT wiring termination, including connections at Electronic Temperature Monitoring devices where provided. CT connections via "set-screw" type connectors or wire wrapped around screw terminals is not acceptable.
- 12.11.2.4 Wiring shall be installed in a weatherproof metal conduit system which shall be effectively sealed.
- 12.11.2.5 Wire fill in conduit shall meet NEC requirements for both # of wires per conduit and % fill.
- 12.11.2.6 All CT leads longer than 12 inches inside the tank shall be run in non-metallic tubes instead of being tied directly to supports. All wiring entrances and exits from the tube shall be flared round to prevent sharp edges that could damage wiring during shipment or other movement. Leads shall be tied off with cotton tape where they enter and exit the tubing to prevent unnecessary movement.
- 12.11.2.7 If CT turrets require removal for transformer shipment, CT lead junction boxes shall be installed on the removable turret with the CT's factory installed in the turrets and wired out to the junction boxes. Prefabricated and pre terminated extension cable pigtails and short sections of liquid tight flexible conduits shall be used for reconnecting the CT's during field assembly.
- 12.11.2.8 The cabinet containing the CT terminal blocks shall also be equipped with one States type MTS test switch with 2 current shorting poles and sufficient, properly braced, space for future field installation of a 5/5A single ratio auxiliary current transformer.

12.11.2.9 The short-circuiting strips of the blocks shall be grounded.

- 12.11.2.10 Terminal Blocks shall be located in a separate cabinet or, if located in the main control cabinet, they shall be positioned so as to minimize the possibility of personnel making inadvertent contact.
- 12.11.2.11 If a separate CT Cabinet is provided, it shall meet the following requirements:
 - 12.11.2.11.1 The CT Cabinet shall be weatherproof and shall be large enough to provide sufficient room to pull in and terminate the Customer's 4/C #10 cables.
 - 12.11.2.11.2 The bottom of the CT cabinet shall have a removable plate, at least 8" x 12", suitable for the Customer's connections. The dimensions and centerline location of this cabinet shall be clearly shown on the outline drawing.
- 12.11.2.12 Wireways shall be provided for customer wiring.
- 12.11.2.13 Stainless steel hinges and latching door handle shall be provided.
- 12.11.3 Winding temperature (hot-spot) current transformer leads shall be brought to a shortcircuiting type terminal block (EB-27 or Purchaser approved equivalent) in the CT cabinet so that the temperature indicators can be field calibrated. Calibration information shall be included in the test report (CT current correlation to hot spot adder; and heater calibration data.).
- 12.11.4A current transformer nameplate shall be mounted adjacent to the respective terminal block and shall contain the following information. (If space adjacent to the terminal blocks is limited, a single data plate may be mounted on the inside of the door which includes the below information.)
 - 12.11.4.1 Manufacturer's name
 - 12.11.4.2 Manufacturer's type designation
 - 12.11.4.3 Rated frequency
 - 12.11.4.4 IEEE accuracy class
 - 12.11.4.5Connection chart showing winding development, taps, and ratio in terms of primary and secondary current, polarity, pole and pocket location.
 - 12.11.4.6 Curve sheet numbers
 - 12.11.4.7 Thermal Rating Factor
- 12.12 Pressure Relief:
 - 12.12.1 Mechanical pressure relief devices (Qualitrol XPRD) shall be provided on top of the main tank and LTC compartment. Each device shall have ungrounded alarm contacts (for transformer annunciator) and alarm flags visible from the ground
 - 12.12.2The PRD shall be sized by the Seller based on the size of the tank, volume of oil, etc.

12.12.3Alarm contact shall be wired to the MAIN TANK PRESSURE RELIEF annunciator point.

- 12.12.4 Pressure relief device shall be mounted on a raised flange.
- 12.12.5 Pressure relief devices shall be designed to withstand hydraulic pressure of oil in conservator without leaking.
- 12.12.6Discharge of pressure relief device shall be baffled to control direction and extent of spray and facilitate clean-up.
- 12.13 Liquid Insulation System:
 - 12.13.1 Unless oil is required to be provided as specified on the specific transformer data sheet in the Appendix, transformers shall be supplied without oil and shipped in dry breathable air.
 - 12.13.2For transformers that will be shipped in dry air, oil will be supplied by the customer, unless otherwise specified.
 - 12.13.3When a transformer is required to be shipped with oil as per the specific transformer data sheet in the Appendix, a sufficient quantity of oil shall be supplied with the transformer for filling all tanks and radiators to the proper level.
 - 12.13.4 When required to be supplied, mineral oil shall be CrossTrans 206, Type II, inhibited oil supplied in accordance with the attached oil Specification. unless otherwise specified in Data Sheets. This oil specification requires that the oil have a negative gassing tendency.
 - 12.13.4.1 The Manufacturer shall guarantee that any oil used in the transformer is not contaminated and that any level of impurity will not harm equipment or reduce the value of the oil as an insulator or as a cooling medium. Oil used during testing of the transformer and supplied for final installation in the transformer shall be free of detectable Polychlorinated biphenyls (PCB's). The Manufacturer shall be held responsible for the quality of the oil received at the site.
 - 12.13.4.2 The Manufacturer shall be responsible for furnishing all oil required for filling the completely assembled transformer at the Customer's site. The volume of oil delivered to the site shall be at least 500 gallons above the transformer nameplate requirements.
 - 12.13.50il preservation system.
 - 12.13.5.1 Oil inside the transformer tank shall be isolated from the atmosphere by means of an oil preservation system. This system shall be suitable for operation over an ambient temperature range as required in section 4 "Service Conditions."
 - 12.13.5.2 The type of oil preservation system to be supplied is identified on the specific transformer Data Sheets.
 - 12.13.5.3 When an automatic nitrogen regulated system is specified, the system shall include the following:
 - 12.13.5.3.1 Alarms for high and low tank pressure and low cylinder pressure.

- 12.13.5.3.2 Two Nitrogen bottles on an open shelf with chains to secure the bottles. The shelf shall be as close to the tank base as possible, to limit lifting. The high pressure hose to the regulator shall be long enough to allow switching from one bottle to the other without the need to move either bottle.
- 12.13.5.4 When a conservator system is specified, the system shall include the following:
 - 12.13.5.4.1 Conservator for the oil preservation system, where present, shall not obstruct or restrict access to LTC Selector Switches for maintenance. A safety bar shall be incorporated in the design of the conservator tank bottom or support system to permit tying off two persons, 250 pounds each, in accordance with OSHA requirements. Oil line between conservator and main tank shall not be used for tying off workers.
 - 12.13.5.4.2 The seller's standard equipment for maintaining a small head of oil in an air-cell type expansion tank shall be provided so that the main tank remains full at all times Conservator expansion tank oil level gauge with low-level alarm contacts.
 - 12.13.5.4.3 Conservator expansion tank pressure-vacuum bleeder with desiccant breather.
 - 12.13.5.4.4 Gas collection manifold shall be guarded as required for mechanical protection against damage from personnel on top of the tank.
 - 12.13.5.4.5 No gas collection lines shall be attached to maintenance access covers.
 - 12.13.5.4.6 Sample tubing between gas collection manifold and gas detector relay shall be equipped with a quarter turn shutoff valve at the manifold. Handle shall be in line with tubing when valve is open and at right angles to tubing with valve closed. Handle to be painted red to indicate normally open.
 - 12.13.5.4.7 Sample tubing between gas detector relay and sampling valve shall be fully guarded to prevent mechanical damage. Cable ties to flat bars are not considered fully guarded.
 - 12.13.5.4.8 Sample valve to be 3/8 inch with serrated hose nipple, located approximately 60 inches above transformer base.
 - 12.13.5.4.9 A gas collection system with gas detector relay with alarm contacts and with sampling valve shall be provided on each main tank.
 - 12.13.5.4.10 Alarm contact shall be wired to the HIGH MAIN TANK GAS LEVEL annunciator point.
 - 12.13.5.4.11 Each conservator shall have the following accessories:
 - 12.13.5.4.12 Liquid level gage with low level alarm contact. Gage shall be readily visible from ground level and not obscured by any support bracing.
 - 12.13.5.4.13 2" Filling valve with plug and outboard sampling valve to permit installing tygon tubing to drain valve for level indication during oil filling.
 - 12.13.5.4.14 1" Drain valve with plug and removable serrated tubing adapter for tygon tubing.
 - 12.13.5.4.15 Bleeder valves equipped to permit field addition of drain tubing to slop buckets at ground grade during filling operations. Bleeders that allow intentional, uncontrolled oil spills during filling operations are not acceptable.
 - 12.13.5.4.16 Relief vents if required. Conservator shall be designed to withstand 5 psig positive pressure. All top vents shall have pipe caps. Pipe plugs are not acceptable.
 - 12.13.5.4.17 Manual shut off valves shall be provided in each end of the piping between each conservator and its associated transformer compartment to permit isolation of the compartment from the conservator for inspection, installation and maintenance. Valves shall be designed to withstand full vacuum when closed for vacuum filling of the transformer. Valves shall have lever type

handles that are parallel to the piping with the valve open and at right angles to the piping with the valve closed.

- 12.13.5.4.18 Oil lines between the main tank and conservator that pass over load tap changers shall not block access to manhole covers on the tap changer selector switch compartment.
- 12.14 Grounding:
 - 12.14.1 Tank Grounds:
 - 12.14.1.1 Four stainless steel NEMA 2-hole grounding pads shall be provided near each corner of the transformer tank. These pads shall be vertically mounted, welded to the tank wall, and located approximately nine inches from the base.
 - 12.14.1.2Copper ground bus shall be run completely around the transformer near the tank base and connected to the above ground pads.

12.14.2Core ground:

- 12.14.2.1 Core ground leads shall be brought up separately through cover mounted bushings located in a protective box.
- 12.14.2.2 If the core clamp is isolated from the tank, its ground lead shall also be brought up through a cover mounted bushing located in a protective box.
- 12.14.2.3 The protective box shall be provided on the tank cover for the bushings and ground strap(s).
- 12.14.2.4 The core ground strap(s) shall be bolted to a stainless steel grounding pad on the tank cover inside the protective box.
- 12.14.3 Arrester grounds:
 - 12.14.3.1 Ground connections of 1" x ¼" copper bar shall be provided from the surge arresters to the perimeter ground bus of the transformer. Arrester mounting details shall not be used as part of the ground path.
 - 12.14.3.2 Ground bus design shall permit the installation of leakage current monitors and/or discharge counters by the Customer if so desired. Design shall be based on one monitor or counter per three phase set unless otherwise specified. All proposals shall include an adder for insulating sub bases as required.
- 12.14.4LV Neutral Grounds. The LV Neutral shall be connected to the copper ground bus at the base of the tank.
- 12.14.5Cabinet Grounds.
 - 12.14.5.1 Each cabinet mounted on the transformer tank shall be bonded to the transformer tank with a copper grounding conductor (#1/0 copper minimum).
 - 12.14.5.2Component equipment and case grounds shall be bonded to the control cabinet ground bus.
 - 12.14.5.3 The control cabinet ground bus shall include a minimum of 6 spare positions for future use by the customer.
 - 12.14.5.4 Control Circuit neutrals shall not be bonded to the cabinet ground bus.
- 12.14.6LTC control circuit grounds. The ground associated with the PT input to the 90 relay shall not be connected to the control cabinet ground. The ground for the PT input to the 90 relay will be made at one location determined by the customer.
- 12.14.7 Exposed copper grounding conductors/buses shall be painted to minimize theft.

12.15 External Clearances:

12.15.1 The phase-to-phase clearance between arrester live parts shall be equal to or greater than the phase-to-phase clearance between transformer bushing live parts.

- 12.15.2Phase spacing at the cover mounted bushing terminals shall meet the following minimum requirements:
 - 12.15.2.1 For 345 kV System Voltage 120" on center.
 - 12.15.2.2 For 115 kV System Voltage 60" on center.
 - 12.15.2.3 For 69 kV System Voltage 48" on center.
 - 12.15.2.4 For 15kV, 25kV and 34.5 kV System Voltage 36" on center.
 - 12.15.2.5 For 5kV System Voltage (and below) 18" on center.
- 12.15.3Line to ground clearances
 - 12.15.3.1 Line to ground clearances for live parts not enclosed in air terminal chambers shall meet or exceed the strike distance of the bushings with which they are associated.
 - 12.15.3.2 Line to ground clearances for live parts that are enclosed in air terminal chambers shall meet or exceed standard NEMA spacing.
- 12.15.4 The transformer height dimension shall be sufficient so that the minimum height from transformer base to ground end of all bushings and arresters meets the following criteria for the associated BIL:
 - 12.15.4.19'-0" for 110 kV BIL
 - 12.15.4.29'-3" for 150 kV BIL
 - 12.15.4.39'-6" for 200 kV BIL
 - 12.15.4.411'-0" for 450 kV BIL or 550kV BIL
 - 12.15.4.515'-6" for 1050 kV BIL
- 12.16 Painting and Colors:
 - 12.16.1 Transformer tank, radiators, control cabinet(s), and copper grounding conductors/buses shall be painted ANSI No. 70 light gray.
 - 12.16.2 The finish on the outside surfaces of the transformer and all its accessories shall be pigment type paint suitable for outdoor duty. After priming, two or more finish coats shall be applied to achieve a dry film thickness of at least 3 mils, with average coverage to be at least 4 mils. The transformer shall be finish-painted with ANSI No. 70 light gray paint. In addition, bushings shall be provided with gray porcelain conforming as closely as possible to ANSI No. 70.
 - 12.16.3The tank interior shall be painted white.
 - 12.16.4 The tank cover shall be painted with skid-resistant paint.

12.16.5 Special consideration shall be given to the preparation of aluminum or galvanized conduits and cabinets before painting in order to assure proper bond.

- 12.17 Other ancillary equipment:
 - 12.17.1 All conduit supplied on the transformer shall be threaded, rigid type. Short runs (< 18") of flexible conduit may be used to facilitate connection to devices such as indicators.
 - 12.17.2Gaskets:
 - 12.17.2.1 Gaskets shall be of nitrile rubber.
 - 12.17.2.2 Metal surfaces to which gaskets are applied shall be finished smooth, seamless, and shall be designed with sufficient rigidity to assure proper compression of the gaskets.
 - 12.17.2.3 Machine grooves shall be provided so that over-compression of the gaskets cannot occur, unless it is demonstrated to the Purchaser's satisfaction that the manufacturer is using another gasketing system of high quality and reliability.
 - 12.17.2.4 Final drawings shall include a gasket dimension sheet which identifies quantities and dimensions of all gaskets associated with the tank pressure boundary.
 - 12.17.2.5 One full set of gaskets shall be provided, along with drawings identifying all gasket dimensions and quantities.

13 Testing Requirements

- 13.1 All applicable standard and special test requirements shall apply to each transformer, whether manufactured separately or at the same time as other identical units. Data from identical or similar transformers is not acceptable.
- 13.2 Transformers shall be fully assembled including all auxiliary devices, surge arresters, DGA monitoring equipment, conduits and the wiring of the control cabinet, (the transformer shall be completely assembled and ready for energization) before testing.
- 13.3 All test results, measurements, and calculated values shall be recorded on the supplier's certified test report.
- 13.4 The Purchaser shall have the option of witnessing all tests. The Seller shall advise the Purchaser at least two weeks in advance of test dates so travel arrangements may be made.
- 13.5 In the event of a test failure, no corrective action shall be taken until authorized by the Purchaser.
- 13.6 In no case shall a transformer be shipped without clearance from the Purchaser if test values do not meet the requirements of this specification or other requirements stated in the purchase order.
- 13.7 If a Y-winding is specified, whether the terminals are specified to be brought out or buried, the Y-winding voltage and capacity ratings shall be shown on the test report.
- 13.8 The following tests shall be performed on each unit in accordance with IEEE StandardsC57.12.00 and C57.12.90:
 - 13.8.1 Transformer winding resistance measurements of all windings at all winding tap positions shall be taken for each phase of each winding and included in the test report.
 - 13.8.2 Transformer turns ratio tests shall be performed at all tap positions listed in IEEE StandardC57.12.00. The applied voltage, the calculated ratios for each tap position and the measured ratios for each phase of each connection shall all be included in the test report.
 - 13.8.3 Polarity and phase relation tests shall be performed, and the phasor diagram shall be included in the test report.
 - 13.8.4 Excitation (no-load) loss tests shall be performed at the rated voltage tap by the "Three-Wattmeter Method".
 - 13.8.4.1 No-load losses shall be recorded prior to dielectric testing and then again after dielectric testing has been completed. Both test readings shall be included in the test report. Temperature corrections shall be reported per IEEE standards C57.12.00 and C57.12.90.
 - 13.8.4.2 No-Load Loss measurements shall be taken at rated voltage of the tap position which results in maximum excitation of all cores. (At an LTC position that results in the series transformer and/or preventive autotransformer being excited at 100%

rated voltage. i.e. at 16R when only a series transformer is provided, at 15R when both series and PA transformers are provided, or 1R when only a PA is provided.)

- 13.8.4.3 Excitation current measurements shall be taken at 100% and 110% of the rated voltage.
- 13.8.4.4 Current readings for each phase at both voltage levels shall be included in the test report. These current values shall be recorded prior to dielectric testing and then again after dielectric testing has been completed.
- 13.8.4.5 A one-hour core excitation test shall be performed after the completion of all dielectric tests at rated frequency and 110% of the rated voltage. All cores shall be excited to 110%. Therefore, the test shall be performed at an LTC position that results in series transformer and/or preventive autotransformer being excited at 110% rated voltage.
- 13.8.4.6 The one-hour core excitation test shall be followed by the No-load loss test after dielectric.
- 13.8.5 Cooling system loss measurements shall be taken at all stages and shall be included in the test report.
- 13.8.6 Impedance and load loss measurements shall be taken using the three-wattmeter method at all tap positions listed in IEEE Standard C57.12.00.
 - 13.8.6.1 All measurements shall be performed at the base nameplate and maximum 65°C rating for that tap position and recorded in the test report.
 - 13.8.6.2 Impedance and Load Loss data shall be included in the test report for the following tap positions:
 - HV at Tap "1" or "A" LV at Neutral
 - HV at Tap "2" or "B" LV at Neutral
 - HV at Tap "3" or "C" LV at Neutral
 - HV at Tap "3" or "C" LV at 16L (If LTC provided)
 - HV at Tap "3" or "C" LV at 16R (If LTC provided)
 - HV at Tap "4" or "D" LV at Neutral
 - HV at Tap "5" or "E" LV at Neutral

- 13.8.6.3 The transformer's actual impedances for each DETC tap shall not differ from the quoted impedances by more than IEEE tolerances.
- 13.8.6.4 Zero Sequence impedance measurements shall be taken and shall be included in the test report.
- 13.8.6.5 For Wye-Wye transformers, zero sequence impedance measurements shall be taken in accordance with IEEE C57.12.90. A "T" network diagram shall be included in the test report and shall include complex values for Z1, Z2, and Z3. Complex values shall be shown as %R and %jX at base MVA.
- 13.8.7 Temperature tests shall be performed on each transformer.
 - 13.8.7.1 Each transformer shall be tested in accordance with this spec. Test data from a "thermal duplicate transformer" is unacceptable
 - 13.8.7.2 Tests shall be performed at the HV and LV tap positions that produce the highest losses.
 - 13.8.7.3 A standard liquid temperature rise test shall be performed per C57.12.00 and C57.12.90 at the current required to produce total losses. The test report shall include the top oil temperature and the bottom oil temperature rise above ambient temperature. The test report shall also include the ambient temperature during the test.
 - 13.8.7.4 A standard temperature rise test shall be performed per C57.12.00 and C57.12.90, using constant rated current. The average winding temperature rise shall be reported for both ONAN rating as well as top nameplate rating (ONAF/ONAF/ONAF), and shall not exceed 65°C by resistance measurement and 80°C for hot spot winding temperature. The test report shall include the calculated hottest spot temperature for maximum rating. The test report shall also include the ambient temperature during the test.
 - 13.8.7.5 During factory testing, the radiators that will be supplied with the transformer shall be completely assembled and installed and used for cooling during tests.
 - 13.8.7.6 Calibration information for the winding temperature devices shall also be included in the test report. The test report shall include the setpoints of the devices used to initiate auxiliary cooling equipment.
 - 13.8.7.7 Thermovision (infrared) photographs shall be taken during the heat run, and shall be included in the test report.
- 13.8.8 Sound level tests shall be performed on each transformer and shall be in accordance with NEMA Publication TR1 and IEEE Std C57.12.90.
 - 13.8.8.1 Guaranteed sound levels shall be at 100% rated voltage, at rated HV tap and at the LV tap position that produces the highest noise level.
 - 13.8.8.2 Transformers with reactance LTC's shall have their sound level measured at an LTC position that results in the Preventive Autotransformer being excited.

- 13.8.8.3 Where a "Booster" or "Series" transformer is provided, the sound level shall be measured at an LTC position that results in the "Booster" or "Series" transformers being fully excited (LTC position at an extreme).
- 13.8.8.4 Test data from a duplicate unit is unacceptable.
- 13.8.8.5 All values recorded for the sound level shall be included in the test report.
- 13.8.8.6 The test report shall include the type of meter used, and a diagram of the test point locations.
- 13.8.9 Switching Impulse testing.
 - 13.8.9.1 Switching surge tests shall be performed on each transformer with windings rated 110 kV or higher.
 - 13.8.9.2 Switching surge tests shall be applied to each high voltage terminal in accordance with IEEE Standard C57.12.90.
 - 13.8.9.3 Transformers with multiple voltage connections (series-parallel) shall be impulse tested in the parallel configuration.
 - 13.8.9.4 DETC shall be set at the minimum voltage tap position.
 - 13.8.9.5 The switching surge voltage transient shall be a relatively smooth uni-directional wave of negative polarity.
 - 13.8.9.6 The test report shall include test wave characteristics and copies of oscillographs captured during the testing of each phase.
 - 13.8.9.7 Oscillographs shall include timescales and data showing Time to Peak, Time Above 90%, and Time to Zero.
- 13.8.10Lightning Impulse testing.
 - 13.8.10.1 Lightning impulse tests shall be performed on each transformer.
 - 13.8.10.2 Impulse tests shall be performed on each and every line terminal individually.
 - 13.8.10.3 Impulse tests on all line terminals and neutral terminals (X0 and H0 where provided) shall be performed in accordance with IEEE Standards C57.12.00, C57.12.90 and C57.98.
 - 13.8.10.4 Windings with multiple voltage connections (series-parallel) shall be impulse tested in both series and parallel configuration, regardless of voltage class.
 - 13.8.10.5 Windings with connections for either Delta or Wye configuration shall be impulse tested in both Delta and Wye configuration.
 - 13.8.10.6 For HV winding impulse tests, the DETC shall be set at the minimum voltage tap position.

- 13.8.10.7 For LV winding impulse tests, the LTC (where provided) shall be set at the minimum voltage tap position.
- 13.8.10.8 Tests shall include reduced full-wave 50%, chopped wave, and full-wave tests. The test report shall include wave characteristics and copies of oscillogram films taken during each test. The test report shall also include a copy of the wave comparisons or overlays for the reduced full wave and full wave traces for each terminal tested.
- 13.8.11 Low-frequency dielectric tests
 - 13.8.11.1 Applied potential test shall be performed in accordance with C57.12.00-2006 and C57.12.90.
- 13.9 Induced potential testing accompanied by partial discharge (corona) monitoring shall be performed in accordance with C57.12.00 and C57.12.90, with the following additional criteria.
 - 13.9.1 The de-energized tap-changer shall be set on the full winding tap for these tests and actual readings taken shall be included in the test report.
 - 13.9.2 The Test Report shall show the RIV and PD results as well as the actual test voltages.
- 13.10 Doble single phase excitation test.
 - 13.10.1 Excitation current measurements of the high-voltage windings at their full winding tap shall be taken for each phase. Tests shall be performed for LTC transformer as follows:
 - 13.10.2HV at full winding tap, LV at neutral.
 - 13.10.3HV at full winding tap, LV at maximum raise position.
 - 13.10.4 HV at full winding tap, LV at maximum lower position.
 - 13.10.5 HV at full winding tap, LV at 1L or 1R position (reactance type LTCs only).
 - 13.10.6The high- voltage side shall be excited to a potential (approximately ten kilovolts) which will produce an exciting current that is not to exceed 200 milliamperes.
 - 13.10.7 The test report shall include the excitation current value for each phase.
- 13.11 Insulation power factor and capacitance tests shall be performed in accordance with IEEE Standard C57.12.90, Method II (Test with Guard Circuit).
 - 13.11.1 Transformers with delta tertiary stabilizing windings shall be tested as "three-winding transformers."
 - 13.11.2Test results for "Two-Winding Transformers" or "Three-Winding Transformers" as appropriate shall be included in the test report.
- 13.12 Winding insulation resistance tests shall be performed.

- 13.12.1 Transformers with delta tertiary stabilizing windings shall be tested as "three-winding transformers."
- 13.12.2Test results for "Two-Winding Transformers" or "Three-Winding Transformers" as appropriate shall be included in the test report.
- 13.13 Doble SFRA Testing:

Doble SFRA tests shall be performed on every transformer as follows:

- 13.13.1Tests shall be performed with a Doble M5000 series test set. SFRA tests using other manufacturer's equipment are not acceptable.
- 13.13.2Tests shall be performed in accordance with Doble's SFRA Power Transformer Test Specification.
- 13.13.3A CD ROM shall be provided which includes all test files for electronic comparison with future test results.
- 13.13.4Sketches shall be provided showing test set-up with all equipment identified.
- 13.13.5Both open-circuit tests and short-circuit tests shall be performed for the following winding connections for each phase (9 tests per tap configuration):
- 13.13.6HV Winding at maximum tap and LV winding at maximum tap (LTC at maximum boost position)
- 13.13.7HV Winding, at maximum tap and LV Winding at LTC Neutral position.
- 13.13.8For transformers with a reactance-type LTC, an additional set of tests shall be done with the LTC in a bridging position (with preventive autotransformer excited). Position 15R is suggested, but the manufacturer may select an alternate bridging position if it would provide more informative results.
- 13.13.9For Wye-Wye transformers with the corner of the buried delta tertiary brought out and completed externally, one test shall be done on the tertiary winding (Ya-Yb, with all other bushings floating.)
- 13.14 Controls and wiring check, including but not limited to the following:
 - 13.14.1 Point-to-point wiring check.
 - 13.14.2CT tests: Ratio, Polarity, Resistance and Hi-Pot. Also verify wiring to the shorting block in the control cabinet.
 - 13.14.3 Functional check of LTC operation and voltage control including applying voltage to the LTC control relay.
 - 13.14.4 Functional check of all alarms.
 - 13.14.5 Functional check of all other ancillary devices.

13.14.6Hi-pot test of control circuits.

- 13.15 Other tests to be performed and results included in the Test Report.
 - 13.15.1Tank welds shall be given a pressure test by filling the tank with oil and holding 10 psi for six hours, after which all welded seams shall be inspected for leaks.
 - 13.15.2Certified tests shall be provided for metering accuracy current transformers (when used) at burdens B0.1, B0.5, and B2.0; at secondary current of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, and 7.5 amperes. Included as part of the test report, CT's shall be identified by correlating each CT serial number with its respective bushing location (e.g., X1, X2, and X3). Metering CT's are to be capable of overloads consistent with transformer overloading.
 - 13.15.3The De-Energized Tap Changer operating mechanism shall be operated through its full range periodically during the 10 psi pressure test and during de-energized periods in test program and the shaft seals shall be checked for leaks, with each such operation logged on the test report.
- 13.16 Documentation shall be provided for the metering accuracy of relay-class CT's at burdens of B0.1, B0.5, and B2.0; at secondary currents of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, and 7.5 amps.
- 13.17 A core-to-ground megger measurement shall be made after completion of all tests and shall also be included in the test report. Insulation resistance values shall be included in the test report for each core or core section. (Main core, series core, PA core, etc.)
- 13.18 Each bushing shall have its C1 and C2 power factor test performed.
- 13.19 Calculated peak inrush current shall be provided with the test report.
- 13.20 A minimum of three oil samples shall be taken from the transformer main tank and dissolved gas analysis shall be performed per C57.130. DGA results shall be submitted with the test report. If oil is removed before completion of last test, then gas-in-oil tests shall be made before oil is removed and again after oil is replenished.
- 13.21 Samples shall be taken as follows:
 - 13.21.1 After the unit is filled and before any tests are performed. (All gas levels should be negligible).
 - 13.21.2 Immediately after the temperature tests at the maximum force-cooled rating.
 - 13.21.3 After all preliminary and Dielectrics testing.

14 Acceptance Criteria

- 14.1 Winding and Bushing power factor:
 - 14.1.1 Maximum acceptable power factor is 0.5% or manufacturer's criteria, whichever is lower.
 - 14.1.2 For Class I and Class II transformers, the measured partial discharge shall not exceed 200 microvolts and 500 picocoulombs during the enhancement level, and shall not exceed 100 microvolts and 300 picocoulombs during the one-hour level.
 - 14.1.3 The measured levels of gasses generated during the preliminary and dielectrics tests shall not exceed the limits specified below

Dissolved Gas Limits	
Gas	Maximum Generation Rate (ppm per hour while at rated current)
Hydrogen (H ₂)	2
Carbon Monoxide (CO)	5
Carbon Dioxide (CO ₂)	20
Methane (CH ₄)	1
Ethylene (C ₂ H ₄)	Non Detectable
Ethane (C ₂ H ₆)	Non Detectable
Acetylene (C ₂ H ₂)	Non-Detectable
Methane (CH4)Ethylene (C2H4)Ethane (C2H6)Acetylene (C2H2)	1 Non Detectable Non Detectable Non-Detectable

14.2 The measured levels of gasses generated during the temperature rise tests shall not exceed the limits specified below.

Dissolved Gas Limits	
Gas	Maximum Generation Rate (ppm per hour while at rated current)
Hydrogen (H ₂)	10
Carbon Monoxide (CO)	30
Carbon Dioxide (CO ₂)	300
Methane (CH ₄)	2
Ethylene (C ₂ H ₄)	Non Detectable
Ethane (C ₂ H ₆)	1
Acetylene (C ₂ H ₂)	Non-Detectable

15 Shipping And Receiving

- 15.1 Connections for shipment
 - 15.1.1 The transformer shall be shipped with the standard shipping connections as per C57.12.00, unless otherwise specified in the "special requirements" on the data sheet.
- 15.2 Shipment
 - 15.2.1 Factory test data in accordance with this specification shall be provided to the Purchaser for review and approval prior to shipment:
 - 15.2.1.1 All Dielectric testing results including waveforms and test values.
 - 15.2.1.2 All temperature test results.
 - 15.2.1.3 All Doble test results (single phase excitation test, power factor and capacitance)
 - 15.2.1.4 Impedance, load loss and no-load loss.
 - 15.2.1.5 DGA results.
 - 15.2.2 The transformer shall be designed to withstand a minimum shipping force of 2G in the lateral direction, 5G in the longitudinal direction, and 3G in the vertical direction.
 - 15.2.3 Shipping terms are delivery to the pad at the location specified in the Data Sheets and as per section 1.2.3.2, with the Seller to bear all risk of loss or damage while in transit.
 - 15.2.4 Bidders shall verify their ability to ship to Purchaser's specified shipping destination and shall submit written confirmation of this with the submission of bids. Shipment of the transformer via truck is preferred.
 - 15.2.5 Transformers shall be shipped under at least 3 pounds (at 30°C) positive pressure of breathable quality dry air. A gauge with valves and fittings to permit sampling or adding air shall be provided to monitor air pressure until transformer is filled with oil. Shipping accessories shall include appropriate pipe plug or pipe cap to replace shipping gauge.
 - 15.2.6 Small transformers may be shipped oil-filled.
 - 15.2.7 When the Purchase Order also includes the provision of oil, the seller shall fill the transformer with oil at site.
 - 15.2.8 A recording impact meter with two horizontal and one vertical axis indicator shall be mounted on each vehicle used for shipping the core and coil to its destination. The recording shall be made available to the Customer for review. If meter is not tamper proof then it shall be sealed to show evidence of tampering. Impact meter shall only be opened by the Manufacturer's representative in the presence of a Customer representative. The recorder shall be capable of recording the entire transport plus 30 days.
 - 15.2.9 Shipment shall include one complete set of fresh gaskets to replace all those used on equipment removed after factory testing and two sets of fresh gaskets for all access

covers on the tank and tap changer compartments. Gaskets used during factory test and shipping shall not be reused once disturbed. Gaskets shall be packed in plastic bags for protection and identified as to intended location on the transformer.

- 15.2.10 All radiators and associated piping that are disassembled for shipment shall be kept water-tight by using gasketed and bolted metal blanking plates.
- 15.2.11 Pressure vacuum gauges shall be provided by the Seller for the monitoring of gas pressure in the main tank of the transformer during shipping. Gauges shall be mounted so as to be well protected during shipment.
- 15.2.12 Final shipping information and required delivery dates are specified in the Appendix. Delivery earlier than the date listed in the Appendix is not permitted without prior approval from the Purchaser.
- 15.2.13 Delivery of the transformer and all parts and accessories shall be made on the same day. The Purchaser reserves the right to hold a truck so that all offloading can be done on the same day.
- 15.2.14The Seller shall email complete packing list of parts to the Engineer at least 48 hours prior to shipment. Packing list shall include number of shipping groups or separate containers, contents of each container, expected date of arrival, shop order number and substation name.
- 15.2.15No transportation media transfers are to be made without written approval from the Purchaser.
- 15.2.16 The Seller shall provide satisfactory trip lease arrangements where rail shipments to private rail sidings are used.
- 15.3 Receiving
 - 15.3.1 After the Purchaser's representatives have been notified of the transformer's arrival at the specified shipping destination, they and the Seller's representatives will inspect the transformer for apparent damage or loss. In the event there is evidence of loss, damage, or rough handling, the Seller's representative will be responsible for noting such on the carrier's delivery receipt. If the Seller desires to make an internal inspection of a suspect transformer prior to its unloading from the carrier's vehicle, he will be required to pay for any fees related to delays caused by his inspection. If the Seller does not choose to make an internal inspection and instead asks that the transformer be moved to the foundation for oil filling and field testing, the Seller shall be required to bear all transportation charges in addition to the repair or replacement expenses in accordance with the provisions of the General Terms and Conditions and assume full liability if it is necessary for any part of the transformer to be returned to the factory due to concealed damage incurred during shipment.
 - 15.3.2 The Seller shall be responsible for processing any claims against the carrier (rail, water, or road) and for bearing costs, liabilities, etc., in accordance with the provisions of the General Terms and Conditions if it is necessary to return a transformer to a repair shop in order to correct damage incurred during transportation from the factory to the specified shipping destination.

15.3.3 The Seller shall provide receipt inspection criteria.

15.3.4 Field supervision by a qualified employee of the Manufacturer to provide technical assistance during the initial field assembly of the transformer.

Appendices:

- A. Bid Proposal Information Worksheet
- B. Specific Transformer Data Sheet
- C. Specific Transformer Data Sheet (Alternate Bid)
- D. Drawing Schedule
- E. Transformer Oil specification
- F. Drawing 355-C-4.4: Foundation Plan
- G. Drawing 355-C-5.6: Footing Details
- H. Drawing 355-C-6.3: Switchyard Steel Structure Plan & Details
- I. Drawing 355-C7.3: Steel Structure Details
- J. Drawing 355-E.14.4 Model COP2: Colorado Station Yard
- K. COP1 and 2: Nameplate
- L. COP-2 Outline Drawing UGDT-AB-02: Transformer Outline
- M. Existing COP2 location: photo



4.0 Technical Data

120/160/	²⁰⁰ MVA	Rating of the Transformer (HV-L	_V)
40/53.3/	66.6 MVA	Rating of the Tertiary	
ONAN/ONA	AF/ONAF	Type of Cooling	
ANSI C57	,	Standard Transformer Built to(C ANSI C57, Etc.)	SA C88,
60	Hz	Frequency	
Sealed T	Cank - Positive re nitrogen	Type of Oil Preservation System (Conservator, Positive Pressure Tank)	n , Sealed
Overloa	d Ratings ***		(***) The reported values has been calculated assuming that the LTE and STE loading was preceded
120% of :	Top rating MVA	LTE Rating	(by a PLBN loading
	≤ 140 °C	LTE hottest stop temperature	rating with a
	≤ 110 °C	LTE Top oil temperature	constant operating temperatures
≤ 3	.0% per day %	LTE Loss of life per 16hr event	(reached) and both conditions occurring
160% of :	Top rating MVA	STE Rating	Cover a maximum and constant daily
	≤ 180 °C	STE hottest stop temperature	Temperature of 30°C.
	≤ 140 °C	STE Top oil temperature	conditions, specific calculations can be
≤ 5	.0% per day %	STE Loss of life per 15min even	developed as long as the information
Winding)		Lindicated in LEEE C57.91-2011
4.8.1	High Voltage (H)	Winding	(item 9.7, is supplied a
	121	V Maximum Operating Voltage	
	115	KV Rated Voltage	
	Y	Connection	
	450	Rated Winding BIL @ Line I	End

Layer, etc)

Rated Winding BIL @ Neutral End Type of Winding Construction (Disc,

Winding Material (Copper/Aluminum)

325 kV

Disc

Copper

4.8.2

4.8.3

Samdong or PPE

CTC

Samdong or P	PE	Manufacturer of conductor
CTC		Type of conductor (sheet, strap, CTC, etc.)
Paper		Type of conductor insulation (paper, varnish, netting etc)
Full/Partial interleavin	coil g	Winding construction used to protect winding from incoming surges (i.e. Full/Partial coil interleaving, shielded windings etc.)
Low Voltage (X) Winc	ling
73/	kV	Maximum Operating Voltage
61.5	kV	Rated Voltage
Y		Connection
350	kV	Rated Winding BIL @ Line End
150	kV	Rated Winding BIL @ Neutral End
Disc		Type of Winding Construction (Disc, Layer, etc)
Copper		Winding Material (Copper/Aluminum)
Samdong or P	PE	Manufacturer of conductor
СТС		Type of conductor (sheet, strap, CTC, etc.)
Paper		Type of conductor insulation (paper, varnish, netting etc)
Full/Partial	coil	Winding construction used to protect winding from incoming surges (i.e. Full/Partial coil interleaving, shielded windings etc.)
Regulating Vo	Jtage (F	RV) Winding
	kV	Step Voltage
2.5	k\/	Impulse voltage ph-ph & ph-ground
350 / 350		Type of Winding Construction (Tapped
Tapped Heli	x	Helix, Multistart, Layer, etc)
Copper		Winding Material (Copper/Aluminum)

Manufacturer of conductor

Type of conductor (sheet, strap, CTC, etc.)

Paper	Type of conductor insulation (paper, varnish, netting etc)
	Winding construction used to protect winding from incoming surges (i.e.
Building into	Full/Partial coil interleaving, shielded
HV disc winding.	windings etc.)

4.8.4 Tertiary Voltage (Y) Winding

12.475	kV	Rated Voltage
Delta		Connection
125	kV	Rated Winding BIL @ Line End
125	kV	Rated Winding BIL @ Neutral End
Layer		Type of Winding Construction (Disc, Layer, etc)
Copper		Winding Material (Copper/Aluminum)
Samdong or PP	E	Manufacturer of conductor
CTC		Type of conductor (sheet, strap, CTC, etc.)
Paper		Type of conductor insulation (paper, varnish, netting etc)
N/A		Winding construction used to protect winding from incoming surges (i.e. Full/Partial coil interleaving, shielded windings etc.)

4.9 Short Circuit Withstand

 15*In	om@ONAN
2	secs
0.9	

Multiple of rated ONAN current Maximum duration of one fault XO/X1 ratio

4.10 Impedance

HV/LV:	6.61%	@120MVA-Rated Voltage	s%	Positive Sequence @85°C on Base Rating
HV/LV:	5 .9 5%	@120MVA-Rated Voltage	s%	Calculated Zero Seq. @85C on Base Rating
HV/LV:	7.18%	@120MVA-Highest Tap	%	De-energized Tap Changer - Highest Tap
HV/LV:	6.61%	@100MVA-Nominal Tap	%	De-energized Tap Changer - Nominal Tap

CITY OF PALO ALTO UTILITIES

HV/LV:	6.10% @120MVA-Lowest Tap		%
		N/A	%
		N/A	%
		N/A	%
HV/TV:	24.02%	@120MVA-Nominal Tap	%
LV/TV:	15.27%	@120MVA-Nominal Tap	%

4.11 Core

Core	
3	
581.3	In ²
1.7	Tesla
2.04	Tesla

AK STEEL PRODUCT: H-0 CARLITE DR Approximate Equivalent International Grade: M080-23P5

AKSTEEL

4.12 Losses

36 @1xUnom	kW
42 @1.05xUnom	kW
132 @120MVA - 115/61.5kV - 85°C	kW
366 @200MVA - 115/61.5kV - 85°C	kW
5.2	kW

De-energized Tap Changer - Lowest Tap Load Tap Changer - Highest Tap Load Tap Changer - Nominal Tap Load Tap Changer - Lowest Tap HV nominal tap -Tertiary LV nominal tap -Tertiary

Core Type (Shell, Core or Wound) Number of Legs Core Leg Cross Section Flux Density @ Rated Voltage Est. Flux Density at which the core steel saturates Grade of core steel used Manufacturer of steel

No Load Losses
No Load Losses at 105% HV Overvoltage
Load Losses @ Base rating
Load Losses @ Maximum rating
Auxiliary Losses @ Maximum rating

4.13 Regulation

0.33	%
3.15	%
4.18	%

Regulation	@	85	°C	ONAN	- 1.0	P.F.%
Regulation	@	85	°C	ONAN	- 0.9	P.F.%
Regulation	@	85	°C	ONAN	- 0.8	P.F.%

4.14 Sound Level

≤65	dB	Expected Sound Level @ Rated Voltage & Base Rating
≤67	dB	Expected Sound Level @ Rated Voltage & 1 st

≤67		Stage
≤68	dB	Expected Sound Level @ Rated Voltage & 2 nd Stage
≤66	dB	Expected Sound Level @ 105% Rated Voltage & Base Rating
≤67	dB	Expected Sound Level @ 105% Rated Voltage & 1 st Stage
≤68	dB	Expected Sound Level @ 105% Rated Voltage & 2 nd Stage

4.15 Tap Changer

4.15.1 De-energized Tap Changer

+/- 4.348	%	Range in percent
5		Number of Taps
600	Amps	Current Limit of Tap changer
65	°C	Temperature rise at maximum current
High Volta	age	Electrical location of Tap Changer
Detch	<u> </u>	Manufacturer of Tap Changer
Double DA	1 <u>50KC DT0</u> 09	5 Catalog number of Tap Changer

4.15.2 On-Load Tap Changer

N/A	%	Range in percent
N/A		Number of Taps
N/A		Electrical location of Tap Changer
N/A		Manufacturer of Load Tap Changer
N/A		Model of Load Tap Changer
N/A		Type (Resistor or Reactor)
N/A	kV	Rated Maximum service voltage
N/A	kV	Rated BIL of Load Tap Changer
N/A	Amps	Rated Maximum continuous current
N/A	°C	Temperature rise at maximum continuous current
N/A		Number of operations before service @ 100% current
N/A		Number of operations before service @

N/A		50% current
N/A	°C	Lowest operating temperature of OLTC
N/A		Short circuit withstand (% of rated maximum)
N/A	secs	Maximum duration of one fault
N/A		Does the Load Tap changer require a conservator tank

4.16 Auxiliary Equipments

4.16.1 Bushings

High Voltage (H) Bushings

ABB		Manufacturer
RIS		Туре
115N2000BA		Catalogue Number
115	kV	Voltage rating
550	kV	BIL
2000	Amps	Current rating
Yes		Capacitor Tap available

Low Voltage (X) Bushings

ABB		Manufacturer
RIS		Туре
069N3000AA		Catalogue Number
69	kV	Voltage rating
350	kV	BIL
3000	Amps	Current rating

Tertiary Voltage (Y) Bushings

ABB		Manufacturer
RIS		Туре
025N3000AA		Catalogue Number
25	kV	Voltage rating

150	kV	BIL
3000	Amps	Current rating

High Voltage Neutral (H0) Bushings

ABB		Manufacturer
RIS		Туре
025N0412AA		Catalogue Number
25	kV	Voltage rating
150	kV	BIL
1200	Amps	Current rating

Low Voltage Neutral (X0) Bushings

H0 common		Manufacturer
H0 common		Туре
H0 common		Catalogue Number
H0 common	kV	Voltage rating
H0 common	kV	BIL
H0 common	Amps	Current rating

4.16.2 Surge Arresters

High Voltage Surge Arresters

96	kV	Duty Cycle rating
77	kV	Maximum Continuous Operating Voltage
SIEMENS		Manufacturer
3EL2 096		Model

Low Voltage Surge Arresters

3EL2 054		Model
SIEMENS		Manufacturer
43	kV	Maximum Continuous Operating Voltage
54	kV	Duty Cycle rating

4.16.3	Bushing Type Current Transformers	
	SIEMENS	Metering CT's Manufacturer
	Two (2)	Metering CT's Thermal Rating Factor
	SIEMENS	Relaying CT's Manufacturer
	Two (2)	Relaying CT's Thermal Rating Factor
4.16.4	Cooling Equipment	
	Flat plate	Radiator design type (flat plate or plain tube)
	TTP/Tiantong/Sim.	Radiator Manufacturer
	HDG	Radiator Catalog number
	≈12	Number of Radiators
	KRENZ	Fans Manufacturer
	F26D-A9712	Fans Catalog number
	≈16	Number of Fans
	N/A	Pump Manufacturer
	 N / D	Pump Catalog number

4.16.5 Indication, Alarm and Relay Devices

	Manufacturer of Pressure Relief Device
Qualitrol	for Main Tank
XPRD	Model of Pressure Relief Device for Main Tank
N/A	Manufacturer of Pressure Relief Device for OLTC
N/A	Model of Pressure Relief Device for OLTC
QUALITROL	Manufacturer of Electronic Temperature Monitor
_ITM509	Model of Electronic Temperature Monitor
N/A	Manufacturer of DGA Monitor System
N/A	Model of DGA Monitor System
QUALITROL	Manufacturer of Rapid Pressure Rise Relay for Main Tank
900 Series	Model of Rapid Pressure Rise Relay for Main Tank

0	-
N/A	Manufacturer of Rapid Pressure Rise Relay for OLTC
N/A	Model of Rapid Pressure Rise Relay for OLTC
MESSKO	Manufacturer of Top Oil Thermometer
BeTech	Catalog number of Top Oil Thermometer
MESSKO	Manufacturer of Liquid Level Indicator
мто	Catalog number of Liquid Level Indicator
QUALITROL	Manufacturer of Seal-In Relay
909 Series	Catalog number of Seal-In Relay
N/A	Manufacturer of Gas Detector Relay
N/A	Catalog number of Gas Detector Relay
N/A-Please see adder	Manufacturer of Fiber Optic Temperature Probe
N/A-Please see adder	Catalog number of Fiber Optic Temperature Probe

4.17 Oil

NYNAS or CROSSTRANS	Manufacturer's Trade Name
9400 gals(US)	Quantity
0.25% typical	Oxidation inhibitor (percent by weight)
Truck	Method of oil shipment

4.18

Dimensions – provide sketch showing mounting footprint

142 1/2"	in	Width of Base
76"	in	Depth of Base
200"	in	Assembled Height
265"	in	Assembled Width
197"	in	Assembled Depth
150"	in	Shipping Height
265"	in	Shipping Width
115"	in	Shipping Depth

4.19 Weights

128000	lbs	Core and windings
46500	lbs	Tank and fittings
68700	lbs	Oil
254500	lbs	Total
173000	lbs	Shipping Weight

4.20 Shipping

5.0	g's	Max. allowable shipping impact-longitudinal direction
2.0	g's	Max. allowable shipping impact-lateral direction
3.0	g's	Max. allowable shipping impact-Vertical direction
Dry		Shipping Condition (Dry, oil filled)
Truck		Transportation Vehicle (Truck, railroad)
Yes		Identify items removed from shipment

4.21 Warranty

18	months	Standard Warranty period from date of energization Standard Warranty period from date of receipt of shipment on site Extended Warranty period energization/shipment on site
24	months	
54/60	months	

4.22 Winding Layout

Show sketch with all windings in relationship to the core.





RESPONSIBLE

SIEMENS

INNOVATIVE

TRANSFORMER PROPOSAL

Proposal #: 18-1137A, Rev. 1 The City of Palo Alto Utilities Department (CPAU) Colorado Power Station (COP-2) Transformer October 2, 2018

SIEMENS



EXHIBIT "D" - SIEMENS PROPOSAL REV.1

- To: **CITY OF PALO ALTO** 250 Hamilton Avenue Palo Alto, CA 94301
- Attention: Carolyn Bissett Contracts Administrator

Subject: Colorado Power Station (COP-2) Transformer SIEMENS Proposal 18-1137A, Rev. 1

Dear Ms. Bissett,

Siemens Industry, Inc. ("Seller") is glad to present the attached revised Proposal covering 1 x 120/160/200 MVA 115/61.5/12.47 kV Mineral Oil Three-phase liquid filled Power Transformer in accordance with CITY OF PALO ALTO's ("Buyer") request for quotation ("RFQ"), with the exceptions and/or clarifications as stated on this Proposal and attached documents.

The attached Proposal material fully describes our offering, but if you have any questions, please do not hesitate to contact Karen Braida at 707-455-0241 or Boris Salswach at 919-412-0519.

Regards,

SIEMENS INDUSTRY, INC.

Richard Mucha Manager of Business Development Distribution Transformers Siemens Industry, Inc. 4601 Six Forks Road, Suite 500 Raleigh, NC 27609 Andrea Arterbury Finance Manager

c.c. K. Braida / B. Salswach

For more information, check our transformer tool and find out more about our products, the plants worldwide, reference customers, applications and more.

http://www.energy.siemens.com/hq/en/power-transmission/transformers/



PROPOSAL INDEX

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- Section 2 Proposal Terms and Conditions
- Section 3 Technical Proposal
- Section 4 Schedule Information
- Section 5 Delivery and Site Assistance
- Section 6 Contract Terms and Conditions
- Section 7 Cancellation Schedule
- Appendix A Site Service

Attachments

- 1. Siemens Redline of the City of Palo Alto General Conditions
- 2. Bid Form and Noncollusion Statement
- 3. Bidder's Questionnaire
- 4. Bid Bond
- 5. Bid Proposal Information Worksheets and Outline Drawings
- 6. ISO 9001 Certificate
- 7. ISO 14001 Certificate
- 8. OHSAS 18001 Certificate
- 9. ISO 50001 Certificate
- 10. ISO 17025 Certificate
- 11. Organization Chart
- 12. Reference List
- 13. Brochure

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SECTION 1

PROPOSAL SUMMARY

1.1 Pricing & Delivery:

ITEM 1: 1 x Step-Down Power transformer – Mineral Oil 120/160/200 MVA ONAN/ONAF/ONAF – 65 °C rise, 115/61.5/12.47 kV, with DETC (± 2 x 2.174 %) on HV side

Desc	ription	Price (USD)	
Mair	n Transformer Prices (net each unit)		
1	Transformer	\$1,306,727.00	
2	Oil (Quantity 9,400 gallons)	Included in 1	
3	Dress, Test & Oil filling (acc. to Appendix A)	\$138,978.00	
4	Spare Bushing HV	\$16,000.00	
5	Spare Bushing LV	\$12,000.00	
6	Spare Bushing Neutral	\$4,500.00	
7	Spare Set of gaskets	\$2,000.00	
8	Extended warranty (up to 54/60 months included in/out coverage)	\$15,000.00	
9	Transportation (job site)	Included in 1	
10	Offloading (pad)	Included in 1	
11	Technical Field Assistance (Up to 5 days per unit 10 hr each) required to validate warranty	Included in 1	
12	Taxes	Not Included	
	TOTAL	\$1,495,205.00	

Optio	onal Prices - not included in the Transformers	Price (net each)				
13	Spare Bushing TV	\$8,000.00				
14	Hot oil circulation for ambient temp < 10 °C/day/unit	Not needed				
Estimated Schedule						
Ap	oproval Drawings	12 weeks ARO				
Fir	nal Drawings	2 weeks ARAD				
EX	W Delivery	27 weeks ARO				
DE	DP Delivery	32 weeks ARO *				

* In order to meet June 1st as delivery date, a purchase order or notice to proceed must be placed on Siemens latest on October 5th, 2018.

ARO: After Receipt of Order / ARAD: After Receipt of Approval Drawings



Site Assistance Rates for Additional Days for 2019	Price (USD)
Working days (Per 10 hr day - TSE Level 1)	\$2,510.00
Working days overtime (Per hour)	\$290.00
Saturdays (Per 10 hr day)	\$2,900.00
Sundays & Holidays (Per 10 hr day)	\$3,780.00
Premium overtime (Per hour incl after 10 on Sat.)	\$378.00
Travel time (Per hour)	\$207.00 (Not to exceed
	\$1,490.00/day)

Travel, living and incidental expenses not included in hourly rates to be billed at cost, plus 15%

1.2 General Information for All Units: Terms & Conditions							
	Validity Period Price Policy Warranty	30 days from the bid date Firm 54 months from energization / 60 months from delivery, whichever occurs first, without extensions on repaired					
	Limitation of Liability Payment	500% of Unit value of issue Progress payment – NET 30 days from invoice					
Shipping	Origin of Equipment Delivery INCOTERM 2010 Delivery Location Delivery Method	Tenjo, Colombia DDP Job Site 1082 Colorado Ave Palo Alto, CA94303 Truck – Ship- Truck					
Specification	Valid Standard Documents considered in order of precedence	IEEE C57.12.00 1. This Offer 2. COP2 All Appendices.zip 3. IFB 173185 Colorado Transformer B1.pdf					



PROPOSAL TERMS & CONDITIONS

2.1 Terms of Pricing

- 2.1.1 Prices are firm for the quoted delivery.
- 2.1.2 The price does not include any federal, state, or local property, license, privilege, sales, use, excise, value added, gross receipts or similar taxes (other than federal and state income taxes imposed on Siemens). If Buyer claims a tax or other exemption or direct payment permit, it shall provide Siemens with a valid exemption certificate or permit and indemnify, defend and hold Siemens harmless from any taxes, costs and penalties arising out of same. Siemens' prices include the costs of its standard domestic packing only. Unless otherwise specified, when any INCOTERM other than DDP is offered, duties are also not included.
- 2.1.3 Unless specifically indicated in Section 1.1., prices quoted are based on the quantities stated in the proposal and are subject to change for change in transformer quantities;
- 2.1.4 Spare parts prices are valid only if ordered and delivered together with the transformer;
- 2.1.5 Site service is offered as an option and unless specifically noted, prices do not include: Any site specific or Buyer required access and/or safety training, any additional or special and/or site-specific safety, PPE, or environmental requirements, local Sales or Use tax, any required insurance additional to Siemens insurances Requested changes to work scope or delays outside the control of Siemens shall be billed in accordance with Siemens rates. Any additional insurance coverage will be paid by Buyer See appendix A for detailed information about scope and terms;
- 2.1.6 Any agreement arising from this proposal is subject to credit check.
- 2.1.7 Prices include cost for required guarantees.
- 2.1.8 **Export/Import Compliance:** Buyer acknowledges that Siemens is required to comply with applicable export/import laws and regulations relating to the sale, export, import, transfer, assignment, disposal and use of the Products and information provided in the performance of the Services, including any export/import license requirements. Buyer agrees that such goods or information shall not at any time directly or indirectly be used, exported, imported, sold, transferred, assigned or otherwise disposed of in a manner which will result in non-compliance with any export/import laws and regulations. Siemens' continuing performance hereunder is conditioned on compliance with such export/import laws and regulations at all times.



2.2 Payment

15%	Net 30 days after invoice against receipt of the order
25%	Net 30 days after invoice upon drawing submittal approval
25%	Net 30 days after invoice upon successful factory testing
35%	Net 30 days after invoice upon successful field testing but limited to 60 days after delivery

There will be 5% retention until final acceptance or latest 60 days after delivery

In case units cannot be delivered because of reasons not attributable to Siemens Industry, the balance will be due no later than three (3) months after shipment from the factory.

Invoice balances left unpaid after this period shall be subject to additional late payment interest charges. Late payment interest charges shall be calculated on a simple interest basis at a rate of 1.5% per month or part thereof for each month after the allowed payment period.

2.3 Proposal Validity Period

Any offer made hereunder will remain in effect for the number of days stated in Section 1 "Terms & Conditions", unless changed in the interim upon written notice from Company. If a PO is not received within the proposal validity, Siemens reserves the right to modify prices and conditions.

2.4 Confidential Information

This proposal, including all of its attachments, exhibits, appendices, etc. ("Proposal"), is provided "as-is" for your evaluation of Siemens Industry, Inc. as the provider of work discussed therein and contains information that is confidential to and solely owned by Siemens. Your acceptance, viewing or storage of this Proposal is an acknowledgment of a confidential relationship between you and Siemens. We require that this Proposal be returned or destroyed when no longer required for the purpose identified herein. This Proposal and any information obtained from this Proposal may not be re-produced, transmitted, disclosed or otherwise used, in whole or in part, without the prior written authorization of Siemens.

The above terms supersede any click-wrap or other terms not expressly set forth in a signed agreement between the parties covering the Proposal. All such click-wrap or other terms are expressly rejected by Siemens.

2.5 Other terms

This proposal and contract is based upon the Siemens' interpretation of the plans and specifications and it is subject to correction for errors in such plans or specifications. Equipment referenced in the plans or specifications but not in this proposal and contract is not included.



This document constitutes a Proposal of a contract and, when accepted by CITY OF PALO ALTO, shall be included as part of the Contract. This Proposal is expressly limited to the terms contained herein. Siemens hereby objects to and rejects any additional or different terms contained in CITY OF PALO ALTO request for proposal, specification, purchase order or any other oral or written communication from Buyer. Neither Siemens' employees nor its agents are authorized to grant oral warranties or otherwise add to or to modify the terms hereof orally.

Prior to proceeding with any work, Siemens Industry, Inc. requires a formal and complete purchase order. Prior to acceptance, the purchase order must be correct with respect to the agreed upon prices, scope of supply, terms of payment, delivery dates and destinations and must not contain terms and conditions not agreed upon. Failure to submit an acceptable purchase order may result in non-acceptance of the order. The quoted delivery dates are based upon receipt of an acceptable purchase order.

The Contract shall become effective after fulfillment of the following preconditions:

Purchase Order Requirements

In the event a purchase order is generated based on the scope of supply described in this proposal, the purchase order must have the following information included to be considered "clean" and eliminate delays during the order entry process.

1. The customer's Purchase Order must be made payable to:

Siemens Industry, Inc. 4601 Six Forks Road, Suite 500 Raleigh, NC 27609

- 2. The Purchase Order Net Price must match the Proposal Price as outlined in the Proposal summary.
- 3. The Purchase Order Payment Terms must match those outlined in the conditions of sale.
- 4. The Purchase Order Shipping Terms must match the Quoted Shipping Terms in the proposal.
- 5. If the purchase order is based on Siemens Industry, Inc. Commercial Terms and Conditions, this must be indicated on the Purchase Order. If terms have been negotiated, the agreed terms, a statement must be clearly defined on the PO and agreement attached to the PO.
- 6. The correct proposal/revision number/date sent should be referenced on the Purchase Order.

For first time transformer purchases, please provide a tax certificate and W-9 form prior to submitting a purchase order so not to impede the order entry process. Please note, tax forms should have Siemens Industry, Inc. as the vendor.

SECTION 3

TECHNICAL PROPOSAL

3.1 Performance Data :

According to enclosed Proposal Information Worksheets.

3.2 Transformer Scope Details

3.2.1 Electrical and Mechanical Details

- a) Windings and insulation
 - All winding and lead material is copper with thermally upgraded insulation.
 - Circular type core and winding construction.
- b) Tank and general arrangement:
 - Oil preservation system: Inert gas pressure system
 - Lifting hook-up rings, lifting lugs on the cover and jacking pads
 - Stainless steel grounding pads
 - Removable radiators HDG
 - 10 PSI tank design
 - Drain and sampling valves
 - Gaskets in Nitrile, o-ring type
- c) Tap changers
- DETC: Detch or similar

3.2.2 Accessories

- a) HV and LV RIS type bushings, ABB or equivalent. Top mounted.
- b) TV RIS type bushings, ABB or equivalent. Side mounted.
- c) NLTC on HV side Detch or similar
- d) Inert Gas-Presure system
- e) Temperature monitor ITM 509 agreed with specification and clarifications.
- f) Annunciator Alarm Panel SEL2533 agreed with specification and clarifications.
- g) Pressure vacuum gauge with 2 contacts.
- h) Pressure relief valve. 2 contacts.
- i) Oil level indicator. 2 contacts

- j) Winding Temperature Indicator 2 contacts
- k) Oil Temperature indicator
- I) Sudden pressure relay. 1 Contact.
- m) Seal in relay
- n) Skid Base.
- o) Fans and brackets
- p) Earthing screws
- q) NEMA 4 Control Cabinet.
- r) Lifting eyes
- s) Stainless Nameplate
- t) HV & LV Surge arresters.
- u) HV CTs: 1600/5 MR C800 0.3%@B1.8 (Relaying). Qty.: 2 each per phase
- v) LV CTs: 2000/5 MR 0.3%@B1.8 (Metering). Qty.: 2 each per phase
- w) LV CTs: 2000/5 MR WTI (Winding Temperature). Qty.: 1 each per phase
- x) Neutral CTs: 1200/5 MR 0.3%@B2.0 (Relaying). Qty.: 1
- y) TV CTs: 1200/5 MR 0.3%@B2.0 (Relaying). Qty.: 1 each per phase
- z) Filling and venting devices Ball type except radiators valves.
- aa) 1.5" inch ball valve provision for future installation of a gas-in oil monitor
- bb) Sampling device
- cc) Weld on bracket GM135 type agreed with specification.

3.2.3 Excluded items

Unless specifically noted, prices do not include:

- a) Monitoring system and any remote command;
- b) Common cubiculum or enclosures;
- c) Connections, grounding cables;
- d) Fire protection or Fire Fighting Equipment
- e) Busbar system and all accessories related with and/or any other special device;

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- f) Anchor bolts or other anchoring system;
- g) Field tests and spare parts / Remote supervisory indications;
- h) Commissioning
- i) Training;
- j) Airway tickets for design review, meetings and inspections;
- k) Special tools for erection, maintenance, operation and supervision;
- I) Rails, housing and civil work;
- m) Padlocks respectively Padlock system;
- n) Safety equipment e.g. Latchway system;
- o) NGR's
- p) Other devices no mentioned on this proposal

3.3 Technical Clarification/Exception

3.3.1 General

- a) The unit will be designed per applicable ANSI, ASTM and IEEE standards except that internal and external hardware will be metric except for points of Buyer connection such as bushing and arrester terminals, ground pads, vacuum connection, and oil handling connections, all of which will have ANSI standards threads;
- b) Paint will be in accordance with Siemens standard;
- c) Standard tests according to C57.12.00 and C57.12.90. Unless otherwise clearly stated, heat run will be performed only in the first unit of more duplicate units.
- d) Tests to be executed at the factory and witnessed by the Purchaser will be performed according to the applicable technical standards. We reserve the right to perform the tests during the night, weekends or holidays depending on the test field necessities. Transformer test will be performed with the available test oil in the factory;
- e) Dimensions and weights could have variations once finished the final design, those will be confirmed once the order be received.
- f) Dimensions and weights could suffer variations with the final drawings within the tolerance; it will be confirmed with the approval drawings.
- g) Max. THD 5%
- h) We assume the field assembly to take place as per the schedule informed in the Invitation for Bid, that is, June 2019, latest during summer 2019, so a Hot oil circulation for ambient temp < 10 °C will not be needed.

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SCHEDULE INFORMATION

4.1 Delivery Time

The delivery time indicated in Section 1 of this Proposal is/are an estimate and subject to prior sale. If a different delivery is required, Siemens Proposal will be revised and modifications (if any) will be notified to Buyer prior to acceptance. Unless otherwise stated, Delivery dates are approximate only and are not guaranteed. This has to be reviewed if LD's are negotiated and agreed upon.

Note that additional days are required to complete dress, test and oil filling.

4.2 Drawings and documents

Drawings will be provided according to Section 1 "Estimated Schedule".

The approved and/or marked up drawings shall be returned to SIEMENS within 15 (fifteen) calendar days from date they were sent to the Buyer. Delaying their return may result in a later delivery date, which shall not be subject to any applicable liquidated damages.

Changes requested in transformer delivery dates may cause changes in the drawing submittal schedule.

Drawings lead times are subject to confirmation in the event of an order.

Transformer design and tools related to it will be performed at the factory location. All contractual deliverables and submittals will be in English language and all verbal and written communications will be carried out in English language. Our project management will be performed under the PM@Siemens global guidelines that guarantee a flawless project execution and it is available upon request.



DELIVERY AND SITE ASSISTANCE

5.1 Shipping and Delivery Locations

Shipping and delivery location will be in accordance with Section 1 "Shipping". Seaworthy packing is included on all our transformers.

The transformers will be manufactured at a Siemens plant which is certified in accordance with ISO 9001, ISO 14001 and OHSAS 18001.

Siemens Transformers have set up own quality procedures and documents complying with above mentioned Standards. Different procedures and/or documents might be agreed upon. Charges may apply.

In case of order we reserve the right to manufacture the offered equipment in any of our Siemens plants or Siemens joint venture plants.

If final destination(s) is/are not available at the time the Proposal is prepared, prices are subject to change once we are able to obtain freight rates for exact locations.

5.2 Delivery Method

5.2.1 Partial Shipments

Siemens may make partial shipments and shall select method of transportation and route, unless terms of delivery are EXW Factory and CITY OF PALO ALTO specifies the method and route and is to pay the freight costs in addition to the price. The equipment will be shipped as loose cargo. Arresters will be shipped directly from their supplier to the Buyer.

5.2.2 Transportation restrictions

Unit(s) will be shipped as completely assembled as possible. Nevertheless, due to transportation restrictions, parts might be removed for shipping, such as bushings, radiators, fans, conservators, accessories and others. These parts will be shipped by truck to jobsite.

Transformers will be transported oil filled or gas (nitrogen or dry air) filled.

DDP Jobsite: if delivery terms of DDP jobsite are offered, delivery pricing and terms, cost or difficulty of such delivery. Seller shall be provided with free access to the Buyer's designated site assume unobstructed and suitable access to the delivery site, and that no unusual circumstances, conditions or difficulties exist on or near the delivery site (including, but not limited to, insufficient roads, impassable conditions, unstable soil, or extreme grade) that would prevent delivery to the site or increase the



timefor delivery and unloading of the equipment on the pad, without obstructions such as fencing, walls, structures, overhead lines, insufficiently compacted soil (necessitating matting), oil containment pits or dikes around pad, load limits due to underground facilities or soil conditions, debris, etc. The Buyer shall be responsible for payment of any additional costs resulting from circumstances, conditions or difficulties of the nature described above.

5.2.3 Offloading

Unless otherwise clearly stated in Section 1 offloading from truck to pad is not included in the main price of transformer(s) and it can be offered as an option.

5.2.4 Spare Parts

Spare parts are suitably packed for long term storage in well ventilated rain protected area. Storing guidelines of sub-suppliers have to be considered.

5.2.5 Oil delivery

Oil will be shipped from the manufacturer to the buyer (site).

5.2.6 Delivery Inspection

Siemens is providing an impact recorder to ensure the integrity of your unit during transit. Please note that the impact recorder remains the property of Siemens and must be returned (courier-collect) immediately after the unit's arrival at site. Failure to do so will result in a surcharge of \$6,000 per impact recorder.

A Siemens factory/field technical assistant will perform routine warranty inspection on the transformer either upon site arrival of the transformers or right before dress and test. The inspection will validate warranty and verify that no physical damage has occurred to the transformer during transit.

5.2.7 Storage

This Proposal considers delivery of the unit(s) right after factory acceptance tests. If storage is needed, either at the Siemens facilities or elsewhere, Siemens reserves the right to change the terms and conditions of this Proposal. Charges will apply.



5.2.8 Site Assistance

Unless otherwise stated in Section 1, the transformer price includes technical assistance (Required to validate warranty) after delivery pursuant to the scope below:

- a) A technical advisor to provide directions only during assembly and pre-startup testing at 10 hours a day, for the duration specified under Section 1;
- b) Travel costs such as one round trip, accommodations and rental car for the duration specified under Section 1;

Any additional trips to the jobsite or any extension of this time allowance beyond Siemens' fault would be at an extra charge to Buyer, according to prices of Section 1.

Tools, Arrangements and Equipment for transformer assembly as per attached list must be available locally. No further special tools are required.

If Buyer chooses to subcontract a non-Siemens supplier for any of the site work, the subcontractor must follow the Siemens guidelines included in the instruction book and have prior proven experience in power transformer assembly.

Note: For warranty obligations it is mandatory that the transformer has been installed by Siemens Transformers, or has been installed under the technical field assistance of an engineer approved by Siemens Transformers.



CONTRACT TERMS & CONDITIONS

6. As per City of Palo Alto Design-Build Contract and Design-Build General Conditions and related negotiations held to date.



CANCELLATION SCHEDULE

7.1 Cancellation Schedule

In case of Buyer's decision to cancel the project, Buyer will be liable to cancellation charge in accordance with the schedule below:

	EXW Factory delivery time of the unit(s) - In months									
Cancellation Stage	6	7	8	9	10	11	12	13	14	15
≤ 1 month ARO	20%	20%	15%	15%	10%	10%	10%	10%	10%	10%
2 month ARO	40%	35%	20%	20%	15%	15%	12%	10%	10%	10%
3 month ARO	60%	45%	25%	25%	20%	18%	15%	12%	10%	10%
4 month ARO	80%	60%	30%	30%	25%	20%	18%	15%	12%	10%
5 month ARO	90%	80%	70%	60%	30%	25%	20%	18%	15%	12%
6 month ARO	100%	90%	90%	90%	60%	30%	25%	20%	18%	15%
7 month ARO		100%	95%	95%	90%	60%	30%	25%	20%	18%
8 month ARO			100%	100%	95%	90%	60%	30%	25%	20%
9 month ARO				100%	100%	95%	90%	60%	30%	25%
10 month ARO					100%	100%	95%	90%	60%	30%
11 month ARO						100%	100%	95%	90%	60%
12 month ARO							100%	100%	95%	90%
13 month ARO								100%	100%	95%
14 month ARO									100%	100%
15 month ARO										100%

7.2 Clarification Notes

Note 1: Percentage is related to the transformer price excluding transportation. Cancellation is not allowed after the unit has shipped;

Note 2: ARO – After Receipt of Order;

Note 3: Plus cost of hedging cancellation of the currency on the remaining unpaid balance, in case it applies.



APPENDIX A

SITE SERVICE



SIEMENS INDUSTRY, INC. Installation of: One (1), 166.7MVA, 115kV One (1),200MVA, 115kV City of Palo Alto Colorado Power Station Transformer Palo Alto, CA

1. Scope of Work

Siemens is pleased to provide personnel and equipment to assemble and oil fill your transformer. Work Scope is as follows:

Assembly

- Install bushing turrets
- Install all bushings
- Hang and brace radiators, pumps, and associated cooling fans if applicable
- Mount oil preservation system and associated piping
- Mount lightning arresters
- Terminate associated wiring for alarm devices
- Touch up painting of unit

Oil Filling

- Conduct vacuum leak test
- Pull vacuum for a continuous 24 hours once under 1 torr.
- Oil fill the transformer under vacuum utilizing 0.5 micron filters.

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Testing

- Bushing insulation power factor and capacitance
- Winding insulation power factor and capacitance
- Winding excitation
- SFRA after unit has been assembled
- Surge arrester power factor & watts loss
- Transformer turns ratio on all tap positions
- Current transformer ratio, polarity and excitation measurements
- Current transformer insulation resistance
- Insulation resistance of core, frame and reactor where applicable
- Winding Insulation resistance
- Winding resistance
- Functional check of transformer control cabinet (Automation, controls & protection)
- Oil tests after filling: (syringes, bottles and lab testing to be supplied by Siemens)

Test	Units	Standard
DGA	(ppm)	(ASTM D-3612)
DGA Key Gas / Interpretive Method:		IEEE (C57.104)
Moisture in Oil	(ppm)	(D-1533)
Interfacial Tension	(dynes/cm)	(D-971)
Dielectric Breakdown 1 mm	(kV mm-C)	(D-1816)
Power Factor @ 25C	(%)	(D-924)
Power Factor @ 100C	(%)	(D-924)
Particle Count	(# / 50ml)	(ACFTD / ISO 4406)
Polychlorinated Biphenyl (PCB	(ppm)	(EPA Method 8082)

2. Schedule

- Per the proposed, it is assumed that installation and commissioning of the transformer will be completed no later than September, 2019.
- It is estimated that work scope will take 5 7 days per unit, depending upon weather conditions.
- Schedule of service crews and personnel is subject to prior sale.

3. Clarifications to Scope of Work

Unless specifically addressed in scope of work, the following assumptions have been made in preparation of our Proposal.

- Only one mobilization for execution of scope on all units is included in this proposal. Any additional mobilizations as required to complete scope execution will be considered Extra Work and will be billed at agreed rates.
- This proposal does not include any removal of existing transformer, others to provide free and clear access to transformer including removal of overhead structures.

- Siemens will utilize the services of four (4) Siemens IBEW technicians to execute this job. Prices do not include additional labor or the requirement of local labor due to labor agreements between Customer and other entities. Additional costs will be billed at cost plus 15%.
- The work will be performed in one (1) shift per day, ten (10) hours per shift, 7 days per week work schedule besides the continuous process of vacuum oil filling. Any change in this shift arrangement will result in price changes for additional overtime and inefficiencies that result from either acceleration or deceleration of the work.
- 2 hours for site access/safety training are included in the price. If more time is required, it will be considered as extra work.
- Siemens assumes that we will provide self-verification of completion of work scope. This proposal assumes customer will not require independent verification of Siemens completion of work.
- Purchaser shall be responsible for switching, lock out, and grounding of any equipment necessary to establish safe work area.
- Provide suitable, free, clear, unlimited and compacted access route, roads, areas and overhead line clearances around work location for access of service equipment. Purchaser to provide adequate (approximate area of 150 feet by 250 feet on the ground, immediately adjacent to the transformer(s) for lay-down and staging of materials and equipment during the duration of the project. Overhead line clearances and other EHS procedures and requirements will be per Siemens IMS-1910 Rev. 9 EHS manual.
- All transformer ancillary equipment and materials for dressing out /final assembly will be delivered by Purchaser to within 500 feet of the final assembly location to allow easy and expeditious access throughout assembly process.
- Purchaser shall provide a clean and reliable service of 480 Wye/277 VAC, 3Ø, 60 Hz able to support 400 amps load. If required, Siemens has included an optional price adder for provision of fuel and generator to power the oil processing rig.
- Purchaser shall disconnect and reconnect all external protection, bushing terminations, bus work, control, and relay wiring, as required.
- Not included in this scope is the connection of field circuits to the power station, external connection of bushings, or assembly of fire protection systems.
- Vacuum and oil processing will be performed to the scope of work stated above and no extra provisions have been made for specific particle count, hot oil circulation, and/or cold trap processes etc in this proposal. TOTAL time included in this proposal for vacuum, oil fill and circulation is 2 days/unit. Any additional time as required due to but not limited to additional drying criteria, particle count, interfacial tension, and/or processing requirements will be considered out of scope and will be billed at agreed upon rates.
- Price was calculated considering residual humidity in insulation less than 1%, the humidity of ambient air during installation lower than 75% and the ambient temperature during evacuation period higher than 10 °C. Changes on these conditions can affect processing times and would be quoted and billed as extra work. Two (2) days of hot oil circulation is included in this proposal as a line item price adder incase ambient temperature is less than 10 °C and hot oil circulation needs to be performed. Any deviations should be accounted for at the time of project execution.
- Siemens will compile all crating and waste material in designated area; however, purchaser shall be responsible for disposal of solid wastes. This does NOT include breaking down or separating the packaging materials by type (wood, plastic, metal).

- Purchaser shall provide drum(s) and dispose of all waste, flush, and scrap oil generated in execution of work.
- Purchaser shall provide communication and sanitation facilities.
- No provisions have been included for secondary oil containment as may be required for compliance to local site SPCC programs.
- Siemens intends to utilize its own personnel and equipment, however, if scheduling conflict occurs; Siemens reserves the right to hire subcontractors to assist with the work.
- Stand by time: If after our personnel arrive on site, work is delayed for any reason not in control of Siemens, it will be charged additionally per appropriate equipment and personnel rates (rate sheet for personnel is attached).
- Off-site project management for execution of the scope listed above is included in this proposal. If required by Purchaser, Siemens can provide a price adder for on-site project management.

Unless specifically noted, scope does not include:

- Any additional or special and/or site-specific safety, PPE, or environmental requirements
- Local Sales or Use tax
- Any required insurance additional to Siemens insurances.