



**La
Electricidad
de Caracas**

RIF: J-00021243-0

OBJECT

**CONJUNTO GENERADOR
JOSEFA JOAQUINA SÁNCHEZ BASTIDAS
FASE I - PLANTA PICURE**

**REQUISITION FOR PROPOSAL
13.8 / 69 kV THREE PHASE STEP UP UNIT POWER
TRANSFORMERS (GSU)
TECHNICAL SPECIFICATION**

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Ministerio del Poder Popular
para la **Energía y Petróleo**



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1. SUBJECT

This document specifies the minimum requirements for the design, manufacture, factory tests, transportation and furnishing to site, and supervision of installation and field tests, that the manufacturers shall comply for the Tender for supply of Generator Step Up Power Transformers (GSU) with equipment, material and accessories; and Surge Arresters. The power transformers and surge arresters furnished shall be complete with all accessories ready for installation, connection, and immediate service described in the following paragraph. The power transformers shall be delivered at CGJJSB PLANTA PICURE site, located in Arrecifes-Tacoa, Vargas State, Venezuela, for the project named "Planta Termoeléctrica CGJJSB PLANTA PICURE".

2. SCOPE OF EQUIPMENT SUPPLY

The manufacturer shall supply the following equipment:

1. Two (2) GSU Three Phase Power Transformers, 13.8/69 kV – 45/60/75 MVA.
2. Six (6) Surge Arresters.

The equipment shall comply the following technical aspects.

3. TECHNICAL ASPECTS

Generator Unit Step-up power transformers (GSU), shall be 69 kV nominal secondary, and generator rated voltage nominal primary 13.8 kV, and shall be rated a minimum 5% over generator capability throughout the full ambient operating range with a temperature rise limited to 65°C. The method of cooling shall be ONAN/ONAF/ONAF. Step up transformers for the combustion turbines shall be designed for a minimum guaranteed efficiency of 99.7% at the top ONAF rating.

Transformer high voltage winding BIL shall be a minimum of 350 kV with 110 kV neutral. High voltage bushing shall have minimum BIL of 350 kV. Low voltage winding shall have a minimum BIL of 110 kV. Transformer size, impedance and high side tap shall be selected to allow full range of generator reactive capability at the system nominal voltage. Transformer impedance shall be approximately 10,5 % on an ONAN base and 17,5 % at maximum rating. In addition, transformer impedance shall be selected to limit fault current below generator breaker interrupting level, and allow starting of largest plant motor without exceeding NEMA starting criteria.


Connection:	H1, H2, H3	Bushing to Arrester
	H0	Bus to Ground Pad
	X1, X2, X3	Insulated Cables



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Transformers shall be provided with oil containment and drainage to the plant oil water separator. Drain lines shall be provided with normally closed manual drain valves.

3.1. Standards

All equipment shall conform to the applicable standards of ANSI, IEEE, IEC and NEMA and shall be in accordance with the applicable requirements of OSHA standards. The latest published edition of referenced standards shall apply. The power transformers shall be designed, fabricated, and tested in accordance with ANSI/IEEE C57, series C62, NEMA TR 1, and these Specifications.

Any conflicts between the standards, this document and the datasheets shall be identified by the Manufacturer and notified to the Purchaser in writing for resolution.

3.2. Environmental Conditions and Design Parameters

The power transformers and surge arresters shall be built to withstand the following environmental conditions:

- Maximum environmental temperature: 29,0 °C
- 24 hours Average environmental temperature: 24.0 °C
- Minimum environmental temperature (mean) 22,0 °C
- Height above sea level : 30 m.s.n.m.
- Maximum relative moisture: 95 %
- Maximum sun radiation: 240 w/ m²
- Noise . 80 dB
- Maximum wind velocity 23 km/h

The electrical equipment will be installed in the tropic and shall be protected against fungus, parasites, salt and corrosive dust.

The zone where the equipment will be erected is close to Catia la Mar near La Guaira Harbor, Vargas State, Venezuela. The Tender shall expose in his offer, the actions taken in the design, manufacture and built of the equipment, in order to oppose to the negative effects of the polluted environment described.

3.3. Seismic Conditions and Design Parameters


The design of the GSU power transformer, their windings, isolator bushings, conservator, tank, accessories and supports shall be based on the accelerations corresponding to the elastic design spectrum of the COVENIN N° 1756 standard "Edificaciones Sismoresistentes", and COVENIN N° 3621 standard "Diseño



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Sismorresistente de Instalaciones Industriales”, EDC Standard ND-C-B-01-94 “Diseño sismorresistente para el Sistema Electrico General”.

All the parts of the equipment will be designed inside the elastic range and without reduction for ductility, for earthquake defined by Zone 5 COVENIN N° 1756-2001 the following parameters:

Horizontal Acceleration of terrain $A_o = 0,50 \text{ g.}$

Horizontal Acceleration of terrain $A_v = 0,35 \text{ g.}(0,70 A_o)$

Speed of terrain $V_t = 50 \text{ cm/s.}$

Displacement $e_t = 44 \text{ cm.}$

Importance factor = 1,30

Soil profile = S3 in agreement with COVENIN 1756

Life cycle = 30 to 40 years

The determination of the influence period characteristic for each element with the design acceleration shall be the maker's responsibility, and shall conducted by means of direct vibratory tests or by analysis with appropriate mathematical or analogical models.

The design of all components of the equipment will be such that its natural frequencies don't coincide with those corresponding to impulse, electric or seismic loads.

The vertical component of the seismic acceleration will be at least 70 % of the horizontal acceleration and for the design of anchorages and verification of the stability of the equipment effects will be superimposed with those of the horizontal acceleration using the square root of the sum of the squares.

3.4. Guaranteed Technical Characteristics

The manufacturer shall fill the column “Guarantee” of the attached data sheets and sign each attached page of the Guaranteed Technical Characteristics. These signed datasheets shall be included as part of the proposal.

3.5. General Characteristics

Transformers shall be provided as a minimum with the following characteristics, accessories and capabilities:



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- A. Three phase generator step up power transformers unit (GSU), dielectric mineral oil insulated (Puramin AD66 Recommended or similar), substation type, outdoor use, 13.8/69kV, 45/60/75 MVA; ONAN/ONAF/ONAF, Class 65° C (rise).
- B. Conservator or sealed tank with inert-gas pressure oil preservation system or tank with expansion container.
- C. Connection: Delta 13.8 kV windings(Primary), Star 69 kV windings (Secondary), star neutral brought out for effectively grounding for GSU power transformer
- D. Basic Insulation Level (BIL) 110 kV for primary side and 350 kV for the secondary side and 110 kV for neutral bushing .
- E. Short circuit impedance (Zsc) 10,5 % ONAN rating, 17,5 % ONAF maximum rating.
- F. Copper windings material.
- G. On load tap changer in the 69 kV side of GSU with ten positions 10 x 1% steps above nominal voltage and ten positions 10 x 1% steps below nominal voltage
- H. Factory routine test according to the IEEE standard. The proposal shall include copy of the Type Test for the offered power transformer and surge arresters
- I. The 69 kV bushing shall be Fog Type and terminated for air insulated connection using aluminum cable of 1200 kCM. The low voltage secondary side shall be arranged in a junction box for 13,8 kV cable bottom connection, each connection must be able to accept six 750 MCM / phase . The nominal current of the each group of cables is 4000 A for the 60 MVA power transformer.
- J. The transformer internal protections relays shall be 125 V or 24 V DC fed. The AC auxiliary services shall be fed with 480/277 or 208/120 V system.
- K. Standard angular displacement of voltages as indicated in ANSI/IEEE C57.12.70 and C57.12.116.
- L. Sound level not to exceed 64 dBA at 3 feet at top ONAF rating (or less if required to meet project sound limitations).
- M. Continuous over excitation capability of 110% at full load and 125% for 30 seconds.
- N. Manholes located in cover.
- O. Short circuit capability with only transformer impedance limiting fault current.
- P. Detachable radiators with lifting eyes and upper and lower isolation valves
- Q. Upper and lower filter connections with sample valves
- R. Adequate number of current transformers with relay accuracy of C800 and metering accuracy of 0.3 B1.8 (or as required by interconnect standards) for plant metering and relaying including any relaying interface with substation. Current transformers shall have a minimum thermal rating factor of 2.0. A minimum of three current transformers (two for each phase and one for neutral) on high side with at least one with metering accuracy and two on the low side, and one on each HV and LV terminal for thermal image protection.



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- S. Dual neutral current transformers
- T. Station Class surge arresters (internal surge protection not acceptable) with an MCOV of not less than 110% of line to ground voltage.
- U. Discharge counters
- V. Sudden pressure relay device with dual outputs
- W. Fault protection device mounting provisions
- X. Serveron on-line gas analysis monitor with communications capability to the plant DCS, alarm and configurable analog outputs
- Y. Copper windings with EHV-Weidmann insulation and materials suitable for 120° C continuous operation
- Z. Local annunciator with common alarm or adequate alarms in DCS to quickly identify alarm source
- AA. Qualitrol temperature monitor with a minimum of 8 output contacts, diagnostic alarm, communications capability, and analog outputs.
- BB. Maximum core flux density of 1.7 Tesla at no load and 100% rated tap voltage.
- CC. One spare high and low voltage bushing.
- DD. High temperature gasket material (Viton).
- EE. Accessories:
 - 1. Removable dial-type low level oil indicators with individual contacts for alarm and trip, two levels and adjustable alarm and trip contacts.
 - 2. Oil drain and filled up valve
 - 3. Accessible core ground bushing and well for core ground with a copper bus bar from the neutral grounding resistor until 15 cm above bottom of the tank for grounding connection
 - 4. The technical characteristics should be indicated in a stain-less steel plate, according to the manufacturer standards but submitted to the Purchaser or Owner for approval.
 - 5. Buchholz relay with individual contacts for trip and alarm
 - 6. Oil temperature indicator and level gauges with individual contacts for alarm and trip, two level.
 - 7. Removable dial-type windings indicators with individual contacts for alarm and trip, two levels, capable for remote indication with reset-able drag hand and adjustable alarm and trip contacts
 - 8. Lifting lugs and jacking facilities for handling and maintenance purpose
 - 9. Pressure relief device and indicator with a semaphore visible from ground level
 - 10. Mechanical pressure relief device with automatic resealing-resetting operation, alarm contacts and mechanical signal for indication of the device operation
 - 11. Control cabinet, NEMA 4X, with all accessories required for satisfactory operation



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12. Current transformers according to the datasheet specifications
13. Four ground pads with tapped holes, NEMA two holes drillings, for tank grounding
14. Set of three surge arresters to be installed outside the transformer tank. The surge arrester shall be delivered loose for site installation. The surge arrester shall comply the technical characteristics of the 4.2 attachment.

3.6. Factory Tests


- 3.6.1.** Notify Owner not less than two weeks prior to the starting date of the factory tests to permit observers to be present during the factory tests.
- 3.6.2.** Procedures for factory tests shall conform to ANSI C57.12.90, unless otherwise specified. Except where a specific test method is specified, the factory test report shall state the test method used. Perform the following factory tests on each transformer unless otherwise stated:
 - Winding ratio on rated voltage connections and on all tap positions.
 - Winding polarity and phase relation on the rated voltage connections
 - Excitation loss at 100% and 110% of rated voltages on the rated voltage connections.
 - Excitation current at rated voltages, and at 110% rated voltages, on the rated voltage connections.
 - Impedance and load loss at the maximum 65 °C rating.
 - Temperature rise at the maximum 65 °C rating for the transformer supplied under this contract. Records of temperature tests performed on duplicate or essentially transformers will not be acceptable.
 - Temperature indicator accuracy test.
 - Applied potential test.
 - Induced potential test with the transformer connected at rated voltage, with the transformer's own bushings in place, accompanied by partial discharge monitoring (to conform to ANSI C57.12.90).
 - Lightning impulse tests on all winding terminals, with the transformer's own bushings in place.
 - Switching surge tests on the high-voltage winding, with the transformer's own bushings in place.
 - Test all control wiring for continuity, grounds, and correct connections; and test operation of all relays, indicators, switches, lights, and interlocks.
 - Resistance measurements of all windings on the rated voltage connection and all load tap connections. Test results shall be reported in ohms at 75°C
 - Double insulation power factor tests conforming to Method II in Table 4 of Article 10.10 of ANSI C57.12.90. The power factor shall be equal to or less than 0.5% at 20°C.
 - Perform the manufacturer's standard tests on each surge arrester.



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3.7. Submittals

The manufacturer shall include in his offer, the cost for the all documentation required as follows:

With the Proposal

1. Two printed copies and one electronic copy in AUTOCAD 2007 version of the preliminary general dimension of the transformer.
2. Estimated weight of the transformers, fully assembled and weight of main components for transportation
3. Estimated weight of the surge arresters, fully assembled and weight of components for transportation
4. Filled and signed Guaranteed Technical Characteristics datasheets
5. Copy of the Type Test of the proposed equipment
6. Recommended spare parts list and prices for three years of operation
7. Price for the supervision of installation

After order placement

Two copies of the following drawings shall be submitted, within two weeks after placing the order. Such drawings shall be returned approved by the owner within 4 weeks from issuance:

1. Base drawing, including sufficient details for proper foundation design
2. Outline dimensions of fully assembled transformer and maximum shipping dimensions & weights
3. Estimated weight of the surge arresters, fully assembled and weight of components for transportation
4. Ratings and details of bushings
5. Functional schematic diagram of all power, control, alarm circuits, including point to point wiring diagrams
6. Control Panel details
7. Current transformers curves and resistance values
8. Nameplate
9. Bill of material with complete manufacturer catalogue number and description


All the above drawings shall be sent by the manufacturer in printed copies (two copies) and in AUTOCAD 2007 version. The owner foresee two issues of the above documents



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Two copies of the following documents shall be submitted shipped with the equipment:

1. Final issues of all the above documents(two copies)
2. Data Book including all the documents generated during the design and manufacture of the equipment.
3. Tests Reports
4. Assembly, Operation and Maintenance Instruction Books

4. CONSTRUCTION.

Construction of the power transformers shall be in accordance with the requirements of the paragraphs and articles which follow as applicable.

Step up transformers must match the voltage and power characteristics of the combustion generators which will be established by the Contractor.

The transformers shall be capable of withstanding without damage the stresses caused by short circuits limited only by the transformer impedance on the external terminals of any winding or windings with 125 percent rated voltage maintained across the terminals of all other windings intended for connection to sources of energy. The first cycle asymmetrical peak current shall be as determined in ANSI/IEEE C57.12.00-1980, Article 7.1.5, using the symmetrical short-circuit current calculated from the voltage specified in this paragraph, and using the multiplying factor "K" calculated from the transformer impedance. Temperature limits shall be as specified in ANSI/IEEE C57.12.00, Article 7.3.5. Duration of the short circuits shall be limited to the time periods listed in the following table:

RMS Symmetrical Current in <u>Any Winding</u>	Time Period in <u>Seconds</u>
25 or more times base current	2
20 times base current	3
16.6 times base current	4
14.3 or less times base current	5

4.1. Mechanical Construction.


All tanks, bases, radiators, covers, junction boxes when required, and any other attached compartments shall be fabricated from steel of sufficient strength to withstand normal service stresses without distortion or damage to any part. The base shall be suitable for rolling or skidding in any direction. All tanks and enclosures subject to operating pressures of the oil preservation system shall be designed to withstand 125 percent of the maximum operating pressures, positive or negative, of the oil preservation system



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furnished. In addition, the transformer shall be designed with sufficient bracing and strength to permit essentially full vacuum filling with insulating liquid.

The transformer tank top shall be designed and fabricated to prevent water accumulation (domed) and the tank top shall have a skid resistant surface.

All joints in transformer tanks, radiators, bases, etc., shall be made gastight and oil tight by welding, except that the connections between oil coolers, pumps, and tanks shall be provided with gasketed bolt secured flanges. Unless specified otherwise, all covers shall be welded in place. The transformer shall be equipped with lifting lugs, jack bosses located not less than 15 inches above the base, pulling eyes, and skids.

Ground pads shall be furnished on each transformer tank in accordance with the requirements of ANSI C57.12.10, Article 9.2.8.

Unless alternate acceptable provision is made to prevent corrosion of the exterior of the bottom of the transformer tank, the transformer tank design shall be such that ventilation is provided between the concrete supporting slab and the bottom of the transformer tank. Only supporting steel beneath the bottom of the transformer tank may touch the concrete slab. Design of the steel supporting the transformer tank bottom shall be such that the bottom is accessible for inspection after installation.

4.2. Core and Coils.

Cores and coils shall be in accordance with ANSI C57 standards except as otherwise specified, and shall be braced to withstand short-circuit forces, limited only by the transformer impedance without damage or displacement of the coil on the core and to withstand normal moving and handling without the use of special shipping braces. Suitable cooling liquid passages shall be provided to limit the hot spot temperature rise above the average winding temperature rise at rated load to those values specified in Table 14 of ANSI C57.12.00. The complete core and coil assembly shall be readily removable from the tank for repairs. The coils shall be insulated from the core and each other with sufficient insulation to withstand the standard impulse and low frequency tests for transformers of the specified voltage class. Coils shall be copper.

The core ground connection shall be accessible at a manhole without removing any oil from the transformer tank or climbing into the tank.

4.3. Top Oil Temperature Indicator.


A dial type liquid temperature indicator-relay shall be furnished to indicate top oil temperature. In addition to providing visible indication of the top oil temperature from 0° to 150°C, it shall be equipped with an alarm contact and a trip contact. The indicator



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shall be equipped with a manually reset maximum temperature indicating hand. Location and mounting arrangement shall be such that the sensing element can be removed without loss of oil and it will not interfere with tanking and untanking the transformer core and coils.

4.4. Winding Temperature Detectors for Remote Indication.

A hot spot winding temperature detector for remote indication shall be furnished in the center phase of each winding. Each detector shall be 10 ohms at 25°C and 3 wire. Each resistance temperature detector (RTD) shall be connected to an isolated signal transmitter capable of generating a linearized 0 to 1 milliamp output signal for the remote indication equipment. The transmitter shall be provided with power line fuses and shall obtain power from the Contractor's 120 volt control power bus. The output temperature range shall be 0°C to 150°C. The transducer shall be Rochester Instrument Systems Model No. SC-1372 or acceptable equal.

4.5. Winding Temperature Indicators.

A dial type hot spot winding temperature indicator-relay shall be furnished for the center phase of each winding. In addition to providing visible indication of the temperature of the winding 0° to 150°C with which it is associated, each indicator relay shall be equipped with a separate alarm contact and separate contacts to control the cooling equipment specified hereinafter. Each winding temperature indicator-relay system shall incorporate a current transformer responsive to its associated phase winding current, calibrating resistor, temperature detector element, and heater all mounted and connected to simulate the hot spot temperature of the winding with which it is associated. The winding temperature indicator shall be in accordance with the Owner's current design standard, Kihlstroms Manometerfabrik or equivalent equal.

4.6. Cooling Equipment and Controls.

Integrally mounted equipment shall be furnished to provide the required cooling capacity to maintain the specified transformer rating. Temperature control shall be provided by an assembly of devices, arranged and designed to automatically operate the transformer cooling equipment capacity in steps proportionate to the transformer load and temperature.


The transformer cooling equipment control system shall incorporate the control contacts furnished on the winding temperature indicators specified herein before. Where multiple thermal relays are provided, thermal relay temperature control contacts shall be wired for parallel control of transformer cooling equipment.



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The Contractor will provide one source of 480 or 208/120 volt, 60 Hz, 3-phase, auxiliary power to the transformer control cabinet.

Cooling equipment controls shall be arranged so that no single fault in the control circuitry will cause a loss of more than one half of the cooling system capability.

The transformer cooling equipment controls shall be arranged so that a single remote contact will shut down all fans, regardless of the mode of operation selected (manual or auto). This control will be utilized to aid fire suppression.

The Contractor will provide an indicating alarm to signal the loss of equipment ventilation.

4.7. Auxiliary Power and Control Circuits.

All auxiliary power and control circuits requiring connection to external circuits shall be extended to terminal blocks located in a common weatherproof control cabinet. Terminal blocks shall be equipped with washer head binding screws, covers, and white terminal identification marking strips. Auxiliary power will be served from an external circuit to the one point in the control cabinet.

The control cabinet shall be provided with space heaters to prevent condensation of moisture within the cabinet. Space heater capacity shall be as required to maintain the cabinet internal temperature above the dew point. The heaters shall be spaced away and thermally insulated from any devices or painted surfaces.

Voltage normally applied to the space heaters will be 120 volts. Space heater voltage rating shall be 208 volts.

Space heaters shall be controlled by an adjustable thermostat, factory set to close on falling temperature at 70 F(21°C) (ON) and open on rising temperature at 95°F (23.9°C) (OFF).

Power Transformer Specification and Data Sheets describe auxiliary power supply and indicate control circuit voltage.

If the Contractor chooses to furnish motors or other auxiliary equipment designed to operate at a different voltage from the Contractor-furnished auxiliary power supply, he shall furnish all equipment required to transform the voltage of auxiliary power as supplied by the Contractor to the design voltage of the equipment furnished.


4.8. Current Transformer Circuits.



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All current transformer leads, including those from each tap of each multi ratio bushing current transformer, shall be extended into the transformer control cabinet. The current transformer leads shall be terminated on six-point, shorting type terminal blocks mounted in the transformer control cabinet. The normal operating current of this transformer will be 80% of the primary current value in forced capacitance of the power transformer.

4.9. Insulating Oil.

A sufficient quantity of insulating oil for complete filling to the recommended level shall be furnished with the transformer. The oil shall contain no measurable PCBs. Where possible, the transformer shall be shipped filled to the 25 C oil level. The initial filling of the transformer shall be made under acceptable methods designed to eliminate entrained air from within the tank and windings.

The insulating oil shall meet all the requirements as defined by ANSI/ASTM D3487-79 standards; shall be chemically stable, free from acidity or other corrosive ingredients; shall possess high dielectric strength; shall contain less than 15 ppm water when tested in accordance with the procedures of ASTM D1533 (Karl Fischer method); and shall test at least 30 kV upon receipt at the job delivery point when tested in accordance with the procedures of ASTM D877.

Insulating oil sampling and test procedures at the factory shall conform to the requirements of ASTM D117 (Mineral Oil).

If the dielectric test strength of any oil received in the field, whether shipped separately or in the transformer, tests less than 30 kV when tested in accordance with the procedures of ASTM D877, the Contractor shall provide all labor, supervision, material, and equipment required to furnish the oil quality specified.

The performance of the transformer insulation system shall meet all the requirements of these specifications when oil samples taken from the completely filled transformer have a dielectric test strength of only 26 kV when tested in accordance with the procedures of ASTM D877.

The insulating oil shall be inhibited with 0.3 percent by weight of DBPC (2, 6-ditertiary-butyl para-cresol). The transformer nameplate shall state that the oil is inhibited.


The Contractor shall certify and warrant that the equipment furnished under these specifications contains mineral oil with no measurable PCBs. The equipment shall be replaced at no cost to the Owner should testing indicate that the equipment does not meet this condition.



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A sign shall be affixed to the transformer near the nameplate which states that mineral oil used in the equipment is non-PCB contaminated (CONTAINS NO PCBs).

4.10. Transformer Oil Preservation System.

The oil preservation system shall be of the constant pressure conservator or sealed tank types. The constant pressure conservator precludes direct contact of oil with air and shall include the reservoir tank with air-cell and supports, oil connection to the main tank with shut-off valve, oil level gauge, approved breather facilities, and all other equipment required for satisfactory operation. The liquid level gauge shall be provided with low level alarm contact (Form C) suitable for operation on an under grounded 125 volt DC system, and the leads shall be run to the main terminal box in rigid conduit and be appropriately terminated.

If the sealed tank oil preservation system is provided, all hand hole covers and bushings shall be securely bolted to gasketed openings in the cover and the cover shall be welded in place. Additionally the system shall include a pressure vacuum gauge and a pressure relief device designed to seal the interior of the transformer from the atmosphere and hold the gas as well as oil volume constant without exceeding the internal gas pressure.

4.11. Vacuum Filling.

The transformer shall be designed for essentially full vacuum filling with insulating liquid in the field.

The Contractor shall furnish all oil and supervision required to fill the transformer in the field if required.

4.12. Current Transformers.

Current transformers shall be bushing type with fully distributed windings for relaying service. They shall be five lead multiratio unless indicated otherwise on the Transformer Specification and Data Sheets.

The values indicated in the Data Sheet are minimums. The Contractor will determine the required value as 80% of the normal operating current during forced outage.

4.13. Bushings.


All transformer bushings 110 kV BIL and above shall be oil filled and shall be in accordance with IEEE 21 and IEEE 24, and those bushings 150 kV BIL and above shall be



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interchangeable with oil circuit breaker bushings of the same voltage class and current rating. Bushings rated below 110 kV BIL shall be in accordance with NEMA TR 1.

All bushings above 110 kV BIL shall be provided with facilities for power factor testing.

Bushing minimum clearances shall be in accordance with the requirements of NEMA TR 1-1980, Table TR 1-0.06.

4.14. Surge Arresters.

Station type surge arresters, where specified, shall be mounted near and connected to the high and low voltage bushings. The surge arresters shall be zinc oxide (ZnO).

The arresters shall be mounted so that the minimum clearances specified in NEMA TR 1 for bushings are obtained. Arresters shall be provided with full capacity copper connections (minimum 750 MCM conductor size) between arrester and transformer high voltage bushing terminals to allow transmission line connection to the arresters. Connections between high voltage bushings and arresters shall contain provisions for expansion and contraction. Arresters shall be furnished with line connectors as specified hereinafter and all required ground connections.

4.15. Connectors.

Bolted clamp type ground connectors for two 1/0 AWG to 300 MCM copper conductor shall be provided for each tank grounding pad.

Tinned bronze connectors, stud to NEMA 4 or 6 (as required) hole pad shall be provided on each high and low voltage phase and neutral bushing.

4.16. Undercoat.

A protective undercoating shall be applied to the bottom surfaces of the transformer tank and base.

4.17. Ground Bus.


The transformer shall be equipped with a copper bar ground bus (minimum ¼ inch by 4 inches) connecting each surge arrester and neutral bushing specified to the transformer ground pads at base level.



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4.18. Nameplates.

All major items of equipment and each terminal block in the transformer control cabinet shall be identified with an individual nameplate. Nameplate inscriptions shall be acceptable to the Owner.

4.19. Noise Level.

The Contract Price shall be based on furnishing a transformer with the lowest noise level possible within the manufacturer's standard transformer design.

Information in the Proposal Data section shall be filled in stating the manufacturer's expected highest noise level, and not the average noise levels stated in NEMA TR 1.

5. ACCESSORIES.

Details of the accessories which shall be furnished with each transformer are contained in the paragraphs which follow.

Standard accessories shall be provided according to ANSI C57.12 except there shall be included at least one set of single pole double throw (SPDT) alarm contacts for the following devices: magnetic liquid level indicator; pressure relief device; top oil temperature indicator; oil pump bearing wear monitors; loss of control power and loss of auxiliary ac power alarm devices.

Transformer gauges shall be tilted for ease of reading from the ground within 5 feet of the transformer.

There shall also be included one fault pressure relay system (Buccholz), sensitive to the rate of pressure increase. The fault pressure relay system shall include a single pole single throw (SPST) primary element controlling an auxiliary seal-in relay and reset switch arranged and connected to provide manually resettable lockout function on operation of the primary element. The auxiliary relay shall be designed for satisfactory operation on a 125 volt dc system; shall include four normally open, electrically separate contacts for use with remote equipment; and shall be mounted inside the main control cabinet. All rate of pressure rise relay equipment shall be wired to identified terminal points in the main control cabinet and shall have complete provisions for testing. A local 125 volt dc indicating light shall be furnished to indicate relay reset required. The fault pressure relay shall be Westinghouse Sudden Pressure Relay or Owner approved equal.


Provisions shall be made for connection of the transformer to a McGraw-Edison portable fault-gas detector. Included shall be all tubing and valves required to connect the monitor to the



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nitrogen supply and the gas blanket over the transformer oil. Tubing, valves, and connections shall be as indicated in McGraw-Edison Service Information Bulletin No. S210-70-1.


The GSU power transformer shall be provided with a on-load tap changer on the high voltage winding with tap voltages as indicated on data sheets. The operator for the on-load tap changer shall be provided with an extension to allow local/manual operation of the on-load tap changer at base level and remote/manual control. The on-load tap changer will be accomplished via the DCS (4-20-mA DC output). The on-load tap changer shall comply with ANSI C57-12-10.



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6. PHOTOGRAPHS.

Three complete sets of photographs of each core and coil assembly shall be furnished. The photographs shall be taken just prior to placing the completed core and coil assembly into the tank.

All photographs shall be 8-1/2 inch by 11 inch color gloss prints properly labeled as to the views taken. A total of five different views shall be provided as follows:

- Top view
- Front view, Segment 1 per ANSI C57.12.10 Figure 2
- Left side view, Segment 2 per ANSI C57.12.10 Figure 2
- Rear view, Segment 3 per ANSI C57.12.10 Figure 2
- Right side view, Segment 4 per ANSI C57.12.10 Figure 2

In addition to photographs of the core and coil assembly of the transformer, the Contractor shall furnish three complete sets of photographs of each fully assembled transformer with bushings and all appurtenances in place. The same five views as indicated above for the core and coil assembly shall be provided for these photographs. All photographs shall be express mailed to the Owner within 10 calendar days after they are taken.

7. FACTORY TESTS.

All routine tests specified in ANSI C57.12.00, Article 8.2.1, plus additional tests as specified herein, shall be performed on the transformer. Six certified copies of the report of each test shall be delivered to the Owner not later than 10 days after completion of all factory tests. Temperature tests will not be required, but calculated temperature rise based on tests of similar units of previous manufacture shall be furnished.

The Owner reserves the right to witness testing. The Contractor shall notify the Owner in writing not less than 90 days prior to the scheduled starting date of the factory tests. In addition, the Contractor shall notify the Owner of the performance date for each test not less than 15 days prior to the date of the test to allow the Owner to witness testing if so desired.


The Contractor shall notify the Owner of any unusual event or damage occurring during the fabrication of the transformer and of all tests which do not meet the specified standard values. The Owner reserves the right at their option to inspect such damages or test failures.



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Corrective measures to overcome such damage or failure shall be subject to acceptance by the Owner.

Details of the nonroutine tests which shall be performed on the transformer are contained in the articles which follow.

7.1. Impulse Tests.

Impulse tests shall be performed upon the transformer in accordance with ANSI Standard C57.12.90-1980 using the neutral current method of fault detection. Oscillographic records of the test shall be included in the test reports.

7.2. Partial Discharge Test.

The transformer shall be tested for partial discharge in accordance with the partial discharge procedures specified in ANSI/IEEE C57.12.14, "Induced Voltage Test for Class II Power Transformers" and "Partial Discharge Measurement," except as modified herein. The test voltage shall be determined in accordance with ANSI/IEEE C57.12.00 (1987), Table 5. The partial discharge shall be measured in microvolts at the 50 per cent level and the 70 per cent level of the rated induced test voltage as the test voltage is being increased to maximum. The measured partial discharge above the background shall not exceed 250 microvolts at any time during the test.

In addition, partial discharge inception and extinction voltage levels shall be observed and recorded.

The partial discharge test shall be performed after all other dielectric tests are completed. The curve of the data obtained in the test shall be included in the test reports.

7.3. Additional Tests.

The additional tests described in the following articles shall be performed on the transformer in accordance with applicable ANSI and Owner's standards:

7.3.1. Ratio Tests.

Ratio tests at the rated voltage connection and at all tap connections shall be performed.


7.3.2. Bushing Tests.



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Power factor measurements of bushings shall be provided as individual units.

7.3.3. Megger Tests.

The transformer shall be meggered in accordance with the following procedure. All resistance measurements shall be corrected to 20 ° C.

Megger tests shall be performed with transformer filled with oil and with appropriate bushings interconnected to measure the resistance from high to ground, low to ground, and from high to low. These tests shall be performed utilizing an applied potential of 2500 volts.

In addition, a megger test shall be performed between the core and ground utilizing an applied potential of 500 volts.

7.3.4. Power Factor Tests.

After completion of all other tests specified herein before, power factor tests shall be conducted with bushings and oil in place. The power factor tests shall be conducted using an impressed voltage of 10 kV at 60 hertz. Power factors resulting from these tests shall not exceed 0.5 percent at 20 ° C. The tests shall be conducted as follows:

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

7.3.5. Gas-in-Oil.

After all tests specified hereinbefore are completed, a dissolved gas-in-oil analysis shall be made of the main tank oil.

7.3.6. Dew Point.

The dewpoint of the gas in the tank shall be determined just prior to shipment.


8. WIRING DIAGRAMS.



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Connection and interconnection wiring diagrams furnished by the Contractor shall be in accordance with the EPC document.

9. SHIPPING REQUIREMENTS.

Impact recorders shall be provided with the equipment shipped by truck.

10. TRANSFORMER EVALUATION.

10.1. TRANSFORMER LOSS EVALUATION

The guaranteed transformer losses shall be stated in the appropriate spaces in the Proposal Data section of these specifications.

On initial selection of transformer supplier, Contractor shall provide Owner with the guaranteed load and no load losses for the step-up transformers at the top ONAF rating. In the event the tested losses are greater than the guaranteed losses, Contractor shall reduce the contract price by the sum of \$5,000/ kW for no load losses above the guaranteed value and \$3,000 / kW for the load losses above the guaranteed value. The no load and load loss evaluation will be performed independently of each other.

10.2. OTHER TRANSFORMER PENNALTIES EVALUATION

10.2.1. NO LOAD CURRENT

On initial selection of transformer supplier, Contractor shall provide Owner with the guaranteed 0.1% of no load current for the step-up transformers at the top ONAF rating. in the event the tested current are greater than the guaranteed no load current, Contractor shall reduce the contract price by the sum of \$2,000/ A.

10.2.2. NOISE

On initial selection of transformer supplier, Contractor shall provide Owner with the guaranteed noise level for the step-up transformers at the top ONAF rating. in the event the tested noise are greater than the guaranteed noise level, Contractor shall reduce the contract price by the sum of \$2,000/ db.


10.2.3. FLUX DENSITY



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On initial selection of transformer supplier, Contractor shall provide Owner with the guaranteed 0.01 Tesla of above 1.6 Tesla flux density for the step-up transformers at the top ONAF rating. in the event the tested flux density are greater than the guaranteed flux density, Contractor shall reduce the contract price by the sum of \$10,000.

10.2.4. CURRENT DENSITY

On initial selection of transformer supplier, Contractor shall provide Owner with the guaranteed 0.1 A /mm² of above the specified value of current density for the step-up transformers at the top ONAF rating. in the event the tested current are greater than the guaranteed current density, Contractor shall reduce the contract price by the sum of \$5,000.

10.2.5. TEMPERATURE RISE

On initial selection of transformer supplier, Contractor shall provide Owner with the guaranteed 1° K of temperature rise above the specified value of temperature rise for the step-up transformers at the top ONAF rating. in the event the tested temperature rise are greater than the guaranteed temperature rise, Contractor shall reduce the contract price by the sum of \$20,000.

11. GUARANTEED TECHNICAL CHARACTERISTICS

The manufacturer shall fill the column "Guarantee" of the attached data sheets in Section 12 and sign each attached page of the Guaranteed Technical Characteristics. These signed datasheets shall be included as part of the proposal.

12. ATACHMENTS

12.1. Annex 1. Guaranteed Technical Characteristics. Power transformers data sheet

12.2. Annex 2. Guaranteed Technical Characteristics. Surge arresters data sheet



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RIF: J-00021243-0

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**CONJUNTO GENERADOR
JOSEFA JOAQUINA SÁNCHEZ BASTIDAS
FASE I - PLANTA PICURE**

**REQUISITION FOR PROPOSAL
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TRANSFORMERS (GSU)
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ANNEX 1

Guaranteed Technical Characteristics. Power Transformers Data Sheet



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ANNEX 2

Guaranteed Technical Characteristics. Surge Arresters Data Sheet



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