JAMAICA PUBLIC SERVICE COMPANY, LTD.

The Supply of -

ONE (1) 7.5 MVA, 69 – 6.9KV

GSU POWER TRANSFORMER FOR LOWER WHITE RIVER PLANT

PART 1

TECHNICAL SPECIFICATIONS

Table of Contents

TS.01 Summary of Work

TS.01.1 Description of Works

This specification covers the design, manufacture, factory testing and delivery of one (1) 7.5 MVA, 69-6.9KV GSU power transformer, complete with all necessary fittings, accessories and spare parts. The transformer is to be supplied as per schedule of delivery in 2021.

This transformer is being purchased as a replacement transformer for the GSU transformer at Lower White River Power Station under the substation transformer management program. The other special requirements are outlined in this specification.

TS.01.2 Location

Lower White River Power Station, St. Mary Jamaica.

TS.01.3 Scope of Work

The Supplier shall design, supply, factory test and deliver to Kingston, Jamaica, W.I. all equipment and material in accordance with these specifications.

TS.01.4 Specification Drawings

The Supplier is free to use designs and arrangements that best suit the equipment proposed. Detailed design and provision of proper electrical working clearances, phase to phase, and phase to ground shall be the responsibility of the Supplier.

The dimensions of the power transformer to be supplied should not exceed those as outlined in this specification. Failure to comply will result in rejection of bid.

TS.01.5 Works Not Included

The following work shall not form part of this contract

- Assembly, installation, adjustment and commissioning of equipment on site unless separately and specifically requested by Purchaser.

TS.01.6 Supplier's Drawings and Schedules

The Supplier shall submit two (2) copies of drawing(s) showing any proposed deviations from the original tender, for review by the Purchaser.

The Supplier shall submit, for review, within the time specified in the agreed Work Schedule, two (2) copies of all general assembly drawings, together with such additional detailed drawings as are required or specifically requested to fully demonstrate that all parts of the equipment to be furnished will conform to the provisions and intent of this specification. Any drawing of a preliminary nature must be so indicated.

One copy of each drawing submitted for review will be returned with any necessary changes or comments noted on the drawing. The drawings will be reviewed only for general design, overall dimensions and materials. Review by the Purchaser will not relieve the supplier of responsibility for conformity to the specification, correct details and fit of parts when erected. Only drawings with 'as noted' should be returned for review by the Purchaser. No major revision affecting the design shall be made after a drawing has been approved, without resubmitting the drawing for review. Every revision shall be shown by number, date and subject in a revision block. The symbology to be used shall be in accordance with ANSI Standards.

All applicable requirements in the preceding paragraphs, with reference to drawings, shall apply to catalog cuts, illustrations, printed specifications or any other data submitted.

After reviewed drawings have been received, the Supplier shall without delay complete all necessary corrections or additions and furnish the Purchaser with one (1) reproducible (Mylar or Dylar) copy of each drawing. If minor revisions are made subsequently, one (1) reproducible (Mylar or Dylar) copy of the revised drawing shall be forwarded to the Purchaser.

The Bill of Materials shall be treated as a drawing and one (1) reproducible (Mylar or Dylar) copy shall be furnished.

In addition to the requirements specified in Section TS.02.2 "General Requirements" for drawings related to the equipment being supplied.

TS.02 General Requirements

TS.02.1 Work Schedule

The Supplier shall submit within 15 working days of acceptance of the tender a general Work Schedule showing key dates required for sub-orders and drawing approvals so that the specified delivery date(s) shall be met.

The schedule shall indicate commencement and completion dates for the principal features of the Works including, but not limited to, engineering design and submittal of drawings for review.

TS.02.2 Information to be Submitted by the Supplier

The Supplier shall submit to the purchaser drawings, design data, operation and maintenance manuals, as may be called for herein, or as the purchaser may reasonably require. The Supplier's drawings and design data shall bear the Supplier's official verification that the information shown thereon has been checked by the Supplier and is correct for use in construction, except for drawings of a preliminary nature furnished for information only, which shall be clearly identified as such.

Where applicable, the following drawings and information are to be submitted for approval before manufacture commences.

- Equipment arrangement - plan and elevations
- Dimensioned outline drawings, details and weights of all equipment
- Equipment type test reports
- Nameplate diagram
- Equipment wiring diagrams
- Schematic control diagrams
- Manuals for installation, operation and maintenance of the equipment
- Testing and commissioning procedures

Certification from an independent testing laboratory, attesting that the level of PCBs in the oil is not more than 2 ppm shall be provided.

TS.02.3 Submission and Approval of Drawings

The Supplier shall submit two (2) copies of all drawings, and data to the Purchaser for approval.

The Purchaser will either approve these documents or, request changes or modifications to be made, and shall return one (1) copy to the Supplier within two (2) weeks after receipt of the drawings. The time required for the approval, revision and possible resubmission of drawings must be allowed for in the overall schedule.

The Supplier shall submit for final approval revised copies within two (2) weeks of the receipt of the marked-up drawings. Any manufacturing done before approval of the drawings will be at the Supplier's own risk. The Purchaser will have the right to require the Supplier to make any changes in design which are necessary, in the opinion of the Purchaser, to make the equipment conform to the requirements and intent of the Specifications without additional cost.

All drawings or documents submitted to the Purchaser shall bear the Supplier's stamp "For Approval", the date of submission and the Supplier's signature.

Drawings will be reviewed only for general design, overall dimensions and materials. Approval by the Purchaser of the Supplier's drawings shall not relieve the Supplier of his responsibility for the correctness of his drawings.

Drawings and data shall be submitted within the agreed time after the date on which an order or letter of intent is received by the Supplier.

TS.02.4 Drawing Format

Each Drawing shall have a title block provided at the lower right-hand corner. At least the following information shall be included in the title block:

- the Supplier's name
- the Purchaser's name (Jamaica Public Service Company Limited)
- drawing title (brief description of drawing)
- drawing and revision number
- first date and revision dates
- scale and scale bar (where applicable).

Letters and figures shall be clear, uniform and evenly spaced. The graphical symbols on electrical drawings, diagrams, and other documents shall be in accordance with ANSI standards.

Dimensions of Drawing frames without folding margin shall be as follows:

Drawing	Dimension of Size Drawing Frame (mm)
A1	566 x 801
A2	400 x 566
A3	283 x 394

Outline drawings of major electrical equipment, panels, schematics and substation steel details shall be A1 format.

Units of measure and weights shall be expressed in the metric (SI) system of measurements.

TS.02.5 Installation, Operation and Maintenance Manual

Seven (7) copies of the installation, operation and maintenance manual shall be furnished by the Supplier not later than thirty (30) days before shipment of equipment and materials. This must be written in English.

If this schedule is not met, the supplier shall send the O&M manuals by airfreight to arrive Montego Bay, Jamaica before the equipment.
The manual shall contain the following minimum information:

- General descriptive information
- Assembly and/or erection details
- Operating and Maintenance instructions
- Instructions for testing and adjustments

- One copy of each approved drawing including catalog cuts and other pertinent data.
- Test Certificate(s)
- List of recommended spares
- Equipment insulation curves
- Parts identification list for each item of equipment furnished
- Manufacturer's descriptive information and instructions for all accessory equipment

TS.02.6 Inspection and Testing

All equipment and materials supplied under this Contract shall be subject to inspection and testing by the Purchaser or his appointed representative. Satisfactory completion of such inspection and testing shall not prejudice the right of the Purchaser to reject the equipment if it fails to comply with the Specifications or fulfill the function for which it was intended.

The Supplier shall perform factory tests on all materials, equipment, parts, assemblies and sub-assemblies in accordance with the latest revisions of the applicable standards. The Supplier shall comply in every respect with the provisions of Section GC.08 of the General Conditions of Contract concerning Inspection and Tests of material and equipment.

At least three (3) weeks notice of the date, time and place of all tests shall be given to the Purchaser so that arrangements can be made to witness the tests. The Supplier shall conduct the tests and provide all necessary labor and equipment to carry out the tests.

TS.02.7 Standards

All equipment and materials shall conform to the latest editions of all relevant ANSI standards. Where equipment, components or materials are not covered by appropriate ANSI standards, relevant IEEE, NEMA, ASTM, AISC and AWS shall apply. If equipment or materials conforming to other recognized national standards are offered, the bidder shall submit a copy, in English, of the standard offered and shall itemize the pertinent areas where the standard differs from the requirements of the relevant ANSI standard.

The foregoing referenced standards and their abbreviations are as follows:

Name	Abbreviations
American National Standards, Inc	ANSI
American Society for Testing and Materials	ASTM
National Electrical Manufacturers Ass.	NEMA
Institute of Electrical and Electronic Engineers, Inc.	IEEE
Insulated Cable Engineers Association	ICEA
American Welding Society	AWS
American Institute of Steel Construction	AISC

TS.02.8 System Characteristics

		HIGH VOLTAGE SIDE
(i)	System Phase to phase voltage Maximum operating voltage	69 kV 72.5 kV
(ii)	System BIL	350 kV
(iii)	Number of phases	3
(iv)	Frequency	50 Hz
(v)	System connection	Star
(vi)	Method of Grounding	Solidly Grounded
(vii)	Fault level (symmetrical), MVA	2000

		LOW VOLTAGE SIDE
(i)	System Phase to phase voltage Maximum operating voltage	6.9 kV 7.25 kV
(ii)	System BIL	110 kV
(iii)	Number of phases	3
(iv)	Frequency	50 Hz
(v)	System connection	Delta
(vi)	Method of Grounding	Un-grounded
(vii)	Fault level (symmetrical), MVA	300
(viii)	Auxiliary power supply	240V / 120V, 1 phase, 50Hz

TS.02.9 Environmental Conditions

(i)	Altitude	Sea level.
(ii)	Ambient Temperatures Average 30°C over 24hrs	Maximum 40°C Minimum 15°C
(iii)	Atmospheric Conditions:	Tropical climate subject to direct sunlight, 200 km/hr wind. High salt spray and dust.

The distance of the substations from the sea range: Adjacent to the seashore.

(iv)	Seismic Coefficient	0.25g
(v)	Relative Humidity	maximum - 100% average - 50%

TS.02.10 Preparation for Shipment

The Supplier shall prepare all equipment and their components in such a manner as to facilitate handling and to adequately protect them from contamination, corrosion or damage in-transit and shall be responsible for and make good any or all damages due to improper preparation or loading.

Small or fragile pieces shall be carefully boxed or otherwise protected against loss or damage during shipment. Delicate electrical and other parts shall be boxed in weather-proof containers.

Detachable items such as transformer radiators, transformer bushings shall be removed for shipment and shall be crated in such a way as to prevent weight from being directly placed on the equipment during transportation.

Oil filled shipment of transformers is preferred, but transformers may be shipped under pressure of dry gas. If shipped under pressure of dry gas, sufficient oil shall be provided and shipped in non-returnable steel drums with the transformer. Only new clean drums shall be used.

Transformers are to be fitted with impact recorders prior to shipment.

The impact recorders shall have sufficient data storage and mechanical or battery energy capacity for at least three months operation. Bare and insulated conductors shall be transported on non-returnable steel or wooden reels.
It shall be the responsibility of the Supplier to take any other precautions required to ensure the arrival of the equipment in an undamaged and satisfactory working condition.

It shall be the responsibility of the Supplier to take any other precautions required to ensure the arrival of the equipment at the Purchaser's warehouse in an undamaged and satisfactory working condition.

All crates, wooden reels, sacks and bundles shall be clearly marked to facilitate field identification as follows:

Jamaica Public Service Company Limited.
7.5 MVA GSU Power Transformer

Order No. _____

Jamaica Public Service Co. Ltd.
Kingston,
Jamaica, W.I.

"and any other relevant identification marks"

All external markings shall be legible and durably printed or stenciled on two sides and both ends (where applicable) of containers in letters at least 50 mm high.
In order to facilitate field identification, shipping documents shall include lists with type and quantities of materials contained in each crate.

TS.02.11 Shipping Documents

The following should be adhered to when issuing shipping documents:

(a) Original invoice must be signed and state whether prices are FOB or CIF.
(b) No lot value should appear on the invoice, each item should have a unit price and total value.
(c) A proper description or generic description with part number or catalogue number is required and not part number or catalogue number only.
(d) In the case of NO CHARGE ITEMS state "Value for customs purposes only".

TS.02.12 Tropicalization of Equipment

In the selection of materials and equipment, due regard shall be given to the **harsh, corrosive hot and humid** conditions to which they will be subjected. Untreated organic materials, such as cotton, paper or wood, shall not be used. Operating coils of relays and meters shall be impregnated with a fungus-inhibiting varnish. Marking strips and nameplates shall be of plastic laminate or anodized aluminum. Paper label shall not be used even if protected in a plastic envelope.

Panels, enclosures and cubicles shall totally enclose the equipment. Doors of panels shall be close-fitting and ventilated openings shall be suitably screened to prevent entrance of insects and rodents. All cable entrances to equipment shall be tightly sealed with gland plates. All enclosures containing motors, instruments, control and switching equipment shall be equipped with anti-condensation heaters. The construction of the enclosures and placement of heaters shall be such as to ensure effective air circulation while avoiding local overheating. Internal wiring shall be dual insulated thermoplastic or rubber and Teflon or halogen based non-flammable insulation suitable for a minimum continuous operating temperature of 105^{o}C. All live and exposed conductors and connections shall be suitably insulated to prevent short-circuiting by vermin.

Prior to shipment, surfaces of wiring and all other parts susceptible to moisture absorption or fungus attack shall receive treatment with fungicidal varnish.

TS.02.13 Packing and Delivery

The Supplier shall ensure that all shipments are packed properly for shipment and protected from the harsh environment in which it may be subjected over a long period.

No delivery of equipment or materials shall be initiated without the written approval of the Purchaser. Deliveries should be made in accordance with the Schedule of Deliveries and unnecessarily early delivery will not be acceptable.

All equipment and materials shall be delivered to:

Jamaica Public Service Company Ltd.
Kingston,
Jamaica, W.I

TS.02.14 Design and Workmanship

The design of the equipment and materials shall be such as to give long and continuous service with minimum maintenance under all operating conditions. Equipment shall be of the best quality and most suitable for the function intended, and shall withstand all normal working conditions without deterioration. All equipment shall operate without excessive vibration and noise. Equipment and accessories shall be of well-proven design and provide ease of inspection and maintenance.

The Specification layout drawings showing structures are intended to show only governing dimensions, unless otherwise indicated, and are not intended to define exact details to be furnished.

The Supplier should utilize designs and arrangements to suit his particular equipment and the design loads specified.

TS.02.15 Spare Parts

The Supplier shall supply spare parts required for 2 years normal operation. All spare parts shall be identical to the original parts and shall be properly treated and packed for prolonged storage in the prevailing ambient conditions. Each part shall be clearly identified with its description and function on the outside of the package.
All spare parts shall be shipped with the main equipment and shall be appropriately labeled as spares.

TS.03 Power Transformer

TS.03.1 General

This section of the Specifications covers the design, manufacture, factory testing, guarantee and delivery of one (1) 7.5 MVA, 69-6.9KV GSU power transformer.

TS.03.2 Standards

The Work shall conform to the requirements of all applicable ANSI C57 series standards and all other relevant ANSI standards.

If this Specification conflicts with any of the above standards or codes, this Specification shall have precedence and shall govern. However, the Bidder shall point out these conflicts in his Bid.

TS.03.3 Transformer Type

The transformers shall be a three-phase, two winding, 50-Hz, oil-filled, outdoor type transformer with motor operated off-load tap changer as specified herein. The physical arrangement, that is the location of bushings, surge arresters and other components of the transformer, must conform to ANSI standards as the transformer must be interchangeable with other similar units on the system. Special precaution - provision for corrosion and contamination due to salt spray must be taken into account during design and construction.

TS.03.4 Transformer Ratings

Rated Capacity		7.5 MVA
Temperature Rise		65°C above 40°C ambient
Cooling		ONAN / ONAF
Rated Frequency		50 Hz
Rated Voltage	-high -Low	69 kV 6.9 kV
Connection	-	See table below

Vector Grouping - See table below

Rated Impedance Voltage not less at Base MVA 7.0 - 8.0%

BIL - See table below

Item	Rating	Connection	Vector Group	BIL
1	7.5 MVA 69 / 6.9 kV	Primary Wye Secondary delta	Ynd1	Primary 350KV Secondary 110KV Neutral 95KV

TS.03.5 Short-circuit Withstand Capability

When connected for normal, full-load operation, the transformers shall be capable of withstanding, without injury, a 3-phase or line-to-ground short circuit on any terminal in accordance with the requirements of ANSI.
It shall be assumed that the rated voltage shall be maintained behind the reactance of the system. The values for system fault level to be used for designing short-circuit capability are given in Section TS.02 (General Requirements) of this Specification.

TS.03.6 Losses

In the design of the transformer, the Supplier shall take into consideration the transformer losses which will be evaluated in accordance with the following formula:

Cost of transformer losses = A + B
where
A = US $8465 x kilowatt core loss at rated voltage
B = US $4863 x kilowatt copper loss at maximum OA Rating

The cost of the guaranteed transformer losses will be added to the cost of the transformer in the evaluation of bids.
If the actual transformer losses as determined by shop tests, exceed the guaranteed values, the value of the excess (actual - guaranteed) losses will be calculated using the above formula and that amount deducted from the CIF price of the transformer.

TS.03.7 Surge Arresters

The transformers shall be protected against incoming surges to both the high voltage and low voltage windings by means of surge arresters mounted on brackets attached to the transformer tank. The arresters to be supplied shall be metal oxide gap-less type and shall have a voltage rating suitable for the minimum and maximum transformer tap setting and system over-voltages. Each arrester shall be provided with a surge discharge counter mounted approximately 1.5 m above grade and insulated. The arresters shall have insulated bases and the ground lead supplied from the arrester to the discharge counter shall be insulated.

The arresters shall conform to the requirements of Section TS.07 of this Specification including the provision of suitable terminal connectors.

TS.03.8 Bushings

The transformer shall be supplied with high voltage and low voltage bushings which have a lightning impulse withstand level equal to that of the connected winding.

All bushings shall be designed to eliminate harmful stressing of any parts due to temperature changes and to provide for conductor expansion. All porcelain used in the bushings shall be homogeneous, free from laminations, cavities and have good dielectric quality. The glazing shall be uniform in color and free from blisters, burns and other defects. All porcelain parts shall be one piece, well vitrified, tough and impervious to moisture. All bushing shall be designed for extra-creepage (3.1cm per nominal kV).

The location of the external terminal bushings on the top of the transformer tank shall be strictly in accordance with ANSI standard C57.12.70. ie, H1 bushing shall be on the right hand side when facing the HV side of the tank. All bushings shall be designed such that it is not necessary to lower the oil in the tank to a level, which would expose the winding to atmos¬phere when changing a bushing.
All bushings shall be ANSI 61 Grey in color.

All HV and LV bushings shall be provided with bimetallic clamp type terminal connectors to accommodate cables in the range of 4/0 AWG to 500 kcmils, LV will require 4/0 AWG to 1000 kcmils underground cables ie. Bundle. In addition the following connectors shall be provided loose:
- For HV bushings - Expansion type clamp connectors for 1.5" IPS copper tubing
- For LV bushings - Expansion type clamp connectors for 2.0" IPS copper tubing

TS.03.9 Current Transformers

Each transformer shall be equipped with one bushing type current transformers on each high-voltage and low-voltage bushing. The neutral bushing shall have one current transformer cores.

Current transformer ratios and accuracy ratings shall be:

High voltage Ratio -	600:5 A multi-ratio	Accuracy - C400 at 600:5 A
HV Neutral Ratio -	600:5 A multi-ratio	Accuracy - C400 at 600:5 A
Low voltage Ratio -	1200:5 A multi-ratio	Accuracy - C400 at 1200:5 A

TS.03.10 Tap Changers: (7.5 MVA, 69 – 6.9 kV Generator Transformer)

An off-circuit, manually operated tap changer shall be provided in the high voltage winding and shall be rated for the full FA capacity of the transformer.

The tap changer shall have the following characteristics:

Voltage range	+7.5 - 2.5%
Voltage change per tap	2.5%
No. taps above normal	3
No. of taps below normal	1

The tap changer contacts shall be silver plated, and shall be self cleaning during operation. The tap changer shall have a position indicator, and provision for padlocking the operating mechanism in any

position. The operating handle shall be installed in a convenient location for operation by a person standing on the ground. The tap change mechanism shall be operable by means of both a hand crank and a 240/120 V, 50Hz, single-phase motor.

TS.03.11 Transformer Construction

Core and Coils

The core shall be manufactured of high-grade, cold rolled, grain-oriented, non-aging sheet steel laminations having smooth surfaces. The core steel and all insulation associated with the core shall be designed so that no detrimental changes in physical or electrical properties will occur during the life of the transformer.

The core shall be grounded through externally accessible grounding links located on top of the core to permit testing of the core package for grounds.

The core steel and windings shall be suitably braced to prevent displacement or distortion during transportation and conditions of permissible short circuit and overload. Suitable lifting attachments shall be provided for un-tanking the core and coils with a minimum of headroom. The design and location of lifting points shall be such as to preclude distortion of the core or damage to the core bolt insulation under lifting stresses. Lifting stress shall not be transferred between top and bottom clamps through the core steel.

The windings shall be of high conductivity copper**,** insulated with pure cellulose paper.

TS.03.12 Transformer Tank

The transformer tank shall be constructed by welded metal plates stiffened by suitable steel sections. The transformer shall be fitted with a bolted type cover and the tank shall be one single body with no subdivisions. All the welded seems of the plate shall be as far as possible double welded to ensure adequate mechanical strength as well as oil tightness.
All fabricated steel shall be free from distortion and constructed according to the approved drawings. All oil-filled compartments mounted on the side of the main tank shall have a 12-mm minimum raised lip to prevent dripping of oil with the covers removed.

The cover construction shall include one or more manholes. Each manhole shall be of sufficient size to permit entry of a 0.5-m diameter (minimum) sphere. All manholes, bushings and other major openings in the cover shall have flanges around the edges. The cover shall be constructed so that no water will accumulate on its surface.

To maintain oil tightness, gasketed joints shall be designed and constructed to ensure even and effective pressure without overstressing the gasket, even under conditions experienced during vacuum filling of the main tank. When installed in position, the outer edges shall be protected by metal-to-metal stops or fire-resistant stop gasket material.

A self-resealing mechanical pressure relief device shall be installed, complete with deflector shield, to direct oil away from the control box or tap changer locations. The pressure relief device shall have a mechanical trip indicator and an alarm contact suitable for use on 125-V dc control voltage.

The transformer tank and assembled radiators, but not the conservator, shall be suitable for filling with oil in the field under a vacuum of one atmosphere. The completely assembled transformer with oil shall withstand a pressure of 35 kPa measured at the elevation of the cores.

Base and Jacking Steps

The transformers shall be provided with fixed structural skids, suitable for skidding or rolling the transformer in any direction.

Eyes for attaching hauling equipment shall be supplied on the front and rear of the transformer, so that the transformer may be hauled on or off of it's temporary or permanent locations. Location of the eyes shall be approved by the Purchaser.

The transformers shall be fitted with jacking steps having a 0.35-m clearance from the underside of step to bottom of the base. The steps shall have a minimum free surface of 0.2-m by 0.2-m for the head of the jack. Location of the steps shall permit use of jacks having base dimensions of 0.3-m by 0.3-m without fouling any part of the transformer. The arrangement of jacking steps and base members shall be such that the transformers can be safely jacked in 50mm lifts using a pair of steps parallel to either axis. Each jacking step shall have capacity for lifting one half the weight of the completely assembled transformer filled with oil.

Two ground pads shall be fitted to diagonally opposite corners of the base. Each pad shall include clamp type terminal and bolts suitable for two - No. 7 # 5 (0.428 in dia) copperweld ground wires. Boltholes in the pad shall be to NEMA standard.

Anchor Plates

The transformer shall be provided with two anchor plates welded to the cover, one at each end. These anchor plates shall be of the **"Uni-Anchor Plates" type (part number 17422, plate with tie-off anchor).** They should be able to provide anchoring for the portable fall-arrest anchor post (Uni-Anchor System, part number 16691).

TS.03.13 Conservator Tank

The transformers shall be equipped with an oil-resistant, neoprene rubber bag type oil conservator for oil/air separation.

The conservator shall be equipped with a dehydrating silica gel breather and oil seals shall be accessible from grade level.

The conservator tank shall also have a 50-mm valve with plug at the top of the tank, a sump and a 50-mm drain valve at the lower end of the tank, and a manhole in the end of the tank for inspection and cleaning.

The connecting pipe of the main tank shall be 50-mm diameter minimum, shall project at least 25 mm inside the expansion tank, and shall contain a brass globe valve, with a handle which clearly indicates the position of the valve.

TS.03.14 Cooling Equipment

The necessary heat transfer for the dissipation of heat shall be obtained by the use of an external oil-to-air, heat exchanger.

(a) **Radiators**

The transformer shall be provided with a sufficient number of radiators to permit operation at the self-cooled and forced-cooled ratings without exceeding the specified temperature rise.

Radiator valves shall be provided on each radiator connection to the interconnecting pipe, so that any radiator may be removed for repairs without complete draining of the oil. The radiator valves shall have provisions for locking in the open and closed positions and shall have the open and closed positions clearly marked. Radiators shall be equipped with provisions for draining.

(b) **Fans**

Cooling fans mounted on the radiator structure shall be provided to achieve the forced cooled rating as specified.

Each fan shall form an integral unit with its individual motor. Fan blades shall be made of aluminum alloy, dynamically balanced, and equipped with hot-dipped, galvanized guards.

Fan motors shall be totally enclosed, squirrel cage, weatherproof, 240V, 1-phase, 50-Hz, 80°C rise above 40°C ambient, . Fan motors shall be placed in the path of the cold air flow.

The induction motors shall be of the direct-on-line starting type and shall operate satisfactorily under a voltage fluctuation of +/- 10%.

(c) **Control**

All equipment and components necessary for the control and protection of the fan motors shall be mounted in the main control cabinet. The cooling controls shall be designed for operation at 240V, 50Hz. A “Manual-Off-Auto” heavy duty selector switch shall be provided for the control of the forced cooling stage as follows:

Manual - fans operate
Off - fans stopped
Auto - fans controlled by temperature device.

Means for remote indication of the following conditions shall be provided:

- “Manual-Off-Auto” selector switch position
- Fans operating
- Fan failure
- Loss of control supply

(d) **Oil**

The transformers shall be shipped either filled with oil or inert gas. A sufficient quantity of oil shall be provided in non-returnable drums plus 10% extra.

The oil shall have a dielectric strength, when shipped, of at least 52kV as measured in accordance with ASTM specification D 1816 (2 mm gap).

The oil shall be mineral oil complying with the latest edition of ASTM D 3487 for new transformer insulating oil and shall be suitable for operation at the maximum ambient temperatures stated. Three certified copies of test reports stating the dielectric strength of the oil shall be supplied to the Purchaser with the shipment.

Supplier must also submit three copies of a certificate issued by an independent testing laboratory, attesting that the level of PCB's in the oil is not more than 2 ppm.

TS.03.15 Fittings and Accessories

Each transformer shall be equipped with the following:

(a) Oil valves for filling, draining and sampling in all compartments including the tap changer. The valves shall be suitable for connection to oil purifying equipment.

(b) Two (2) element gas detector relay, located so they collect all gas evolved in the main tank and tap changer compartments. The relay shall be equipped with two sets of contacts, one set to alarm on slow gas accumulation and one set to trip on fast gas accumulation. All pockets or spaces over 80 cm^3 which are vented to the transformer tank shall be piped to the relay. A copper tube, minimum 8-mm ID, shall extend from the gas accumulation element to a suitable valve located on the tank wall near the bottom, to permit bleeding from ground level. A shutoff valve shall be provided in the pipe between the relay and main tank, with the valve position visible from the ground.

(c) Two (2) magnetic oil gauges with dial legible from the ground shall be provided for indication of transformer main tank and tap changer compartments oil levels. Dial markings shall show normal, minimum, maximum and 25°C oil levels. The gauges shall contain two sets of alarm contacts, one set of low-level contacts adjustable on Site, and one set of contacts to close when the oil reaches a dangerously low level.

(d) A dial type oil thermometer, equipped with three separately adjustable contacts, one set to start the forced-air cooling fans, one set adjustable between 60°C and 110°C for alarm, and the other adjustable between 100°C and 125°C for tripping, and with a scale legible from the ground. The temperature-sensitive element shall be installed in an oil-filled or close-fitting well, located in the hottest oil, as far as is practicable.

(e) A winding temperature indicator and relay to indicate the hot-spot temperatures of the windings. Associated plant such as heating coils, thermometer bulb, heating well, gauge and current transformer shall be provided. The indicator-relay shall be automatically reset at approximately 7.5°C ± 2.5°C below the closing temperature, and shall be provided with the following electrically independent, adjustable contacts:

- one set to start the forced air cooling fans
- one set to initiate an alarm, setting to be adjustable between 60°C and 110°C
- one set to initiate tripping, setting to be adjustable between 100°C and 125°C.

The thermometer bulb and the heating coil shall be removable from the well in the tank wall without the loss of liquid or lowering of the oil level.

(f) Two (2) -100-Ω platinum resistance type temperature detectors, one to simulate the winding hot-spot temperature and one for the top oil temperature, shall be provided on the transformer. The RTD and heating coil shall be removable from the well in the tank wall without the loss of liquid or lowering of the oil level. Leads from the temperature detectors shall be terminated in the transformer control cabinet for use with a temperature indicator mounted in the control room.

(g) **Intelligent On-Line Continuous Gas-in-Oil Monitor (Transformer Incipient Fault Monitor)**

The transformer shall be equipped with an Intelligent On-Line continuous gas-in-oil Incipient Fault Monitor similar to (HYDRAN 201R Model i Intelligent transformer incipient fault monitor manufactured by Syprotec).

The fault monitor shall an intelligent transmitter (HYDRAN 201ti) with no moving parts or pump to detect and continuously monitor the evolution of the composite value of hydrogen, carbon monoxide, acetylene and ethylene.

- The fault monitor shall come complete with Dynamic oil sampling features.
- A Communications controller (HYDRAN 201Ci-1) shall provide for Dual Level Visual Alarm Indicators and continuous ppm display for remote and local communication.
- The assembly shall be connected via a 30 foot (9m) interconnecting cable.
- The controller shall provide networking capabilities and shall allow for a single RS-232 entry point.
- The controller shall enable, via RS-485, remote access to as many as 32 other Intelligent On-Line continuous gas-in-oil Incipient Fault Monitor Controllers (HYDRAN 201R Model i or other controllers from the HYDRAN 201i system family)

<u>Installation</u>

- Unless otherwise specified, the Intelligent On-Line Continuous Gas-in-Oil Transmitter (HYDRAN 201Ti) shall be mounted on a One-and-a-half (1-1/2) inch (38mm) ball or gate valve with no internal restrictions, with continuous contact with the oil body. The distance from the sensor to the main oil body shall not exceed nine (9) inches (225mm).
- The valve shall be located on a radiator return pipe and on the discharge side of the pump on a straight section of the pipe. Where an installation on the return pipe is not practical an acceptable alternative shall be to locate the valve on the main transformer tank where good convection flow exist. This special location must be confirmed as being acceptable by the manufacturer (Syprotec)
- In all cases, the valve and sensor shall be located at a height where they can be safely accessed by personnel.
- The valve body shall be at ground (earth) potential.
- A heat dissipater (Heat Fin Adapter by Syprotec) shall be mounted between the valve and the Transmitter.
- The Communications Controller (HYDRAN 201Ci-1) shall be mounted up to 30 feet (9m) away from the transmitter (HYDRAN 201Ti) as standard. Longer distances must be approved by the manufacturer (Syprotec).
- The unit shall be mounted on a vibration-free structure or shall be installed on vibration absorbing mounts available as an option from the manufacturer (Syprotec).
- The unit shall be of NEMA-4X construction and operate in ambient temperatures of -50°C to +55°C.
- The Communication controller shall be connected to the Intelligent On-Line Continuous Gas-in-Oil Transmitter (HYDRAN 201Ti) via a cable supplied by the manufactuer (Syprotec). This cable shall run inside a dedicated steel conduit, rigid or flexible. Splices shall not be permitted.
- The unit shall operate on either 115 VAC (230 VAC on request) at 50HZ. This AC supply cable shall also run inside a separate dedicated steel conduit, rigid or flexible. Splices shall not be permitted.
- The controller shall be effectively grounded.

SPECIFICATIONS

The transformer shall be equipped with an Intelligent On-Line continuous gas-in-oil Incipient Fault Monitor similar to (DYDRAN 201R Model i Intelligent transformer incipient fault monitor manufactured by Syprotec) shall meet the following specifications:

- Display Range: 0 - 2000 PPM
- Accuracy: -/+ 10% of reading and -/+ 25 PPM
- Functions: On-Line Continuous Gas in oil composite reading of:
  hydrogen, carbon monoxide, and Acetylene in varying relative %
  Hourly and Daily Trend
  History and Events Log
  Automatic periodic sensor test
  Calibration, configuration & self-test
  Networking capability
  Modem control
  Remote software upgrading
- Configurable Analog Output Signal:
  Transmitter (H201Ti) Isolated 4-20 mA
  Controller (H201Ci-1) Isolated 0-1mA, 4-20mA, 0-1V, 0-10V
- Alarms: Threshold - Two (2) Gas level alarms adjustable from 0 - full scale
  Trend - Alarming capabilities based on rate of rise
- Alarm contacts: Gas Hi, Gas Hi-Hi, Fail
- Dual level visible alarm indicators
- Serial Port RS-232: Standard
- RS-485 Communications port: Standard
- Data Analysis Software: HYDRAN Host Software
- Installation Tube wrench: Required
- Heat Dissipater: Required
- Vibration absorbing mounts: Required

h. The transformer tap changer shall be provided with pipe fittings and valves brought to one (1) meter above ground level to facilitate filtering of the tap changer oil without operating the tap changer compartment.

i. The transformers shall be equipped with two (2) earthing terminals and connectors for grounding purposes.

Accessories

A weatherproof control cabinet for the cooling fan controls and for the termination and connection of all auxiliary and control leads to the transformer electric equipment shall be provided.

The cabinet shall be conveniently accessible from the ground and shall be equipped with the following.

- Ground bus for individually grounding each circuit requiring ground points.
- A 15-A, 120-V, 3-pin, grounded, duplex, convenience outlet and switched incandescent lamp.
- A suitable pocket or holder for one copy of the instruction manual. A plain removable plate located in the bottom of the cabinet of adequate size for terminating all conduits leaving the transformer. (The plate shall be drilled in the field.)

All control wiring shall be 600-V, flame- and oil-resistant, stranded copper, XLPE insulated wire. Wire sizes shall be appropriate for the function, but not less than 2.5 mm^2 for control circuits. All power and control wiring shall be shielded from metering conductors.

All wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point. Splices or tee connections are not acceptable. Wire runs shall be neatly trunked or in wiring troughs. All wires shall be identified at both ends with sleeve type markers.

Terminal blocks with removable marking strips shall be provided for all circuits and 20% of the total number of spare terminals shall be supplied. Terminal blocks for the current transformer leads shall be of the grounding and short-circuiting type and shall be mounted separately from control terminals.

Terminal blocks should be capable of accommodating a minimum 4 mm^2 wire. External wiring from the control cabinet to transformer accessories shall be run in rigid conduit, except where inappropriate, in which case liquid-tight, flexible metal conduit shall be used.

TS.03.16 Finish

Special consideration must be given to the choice of finish, based on the intended harsh corrosive salt spray conditions in which the transformer will operate.

All exposed un-galvanized metal parts shall be thoroughly cleaned and painted with two primer coats and on the exterior with two finish coats of outdoor, organic, weatherproof paint suitable for a tropical climate subject to direct sunlight and heavy salt pollution. The color shall be light gray.

The base of the transformer designed for grade mounting shall, in addition to the above, be treated with bitumastic compound to prevent corrosion.

The interior of the tank shall be painted with two coats of white or clear, oil-resistant finish.

Each transformer shall be supplied with five (5) liters of touch up paint.

TS.03.17 Nameplates and Marking

Nameplates, instruction plates, labels and tags, warning signs, and any necessary marking whatsoever on the transformer and accessories thereof shall be supplied by the Supplier. The Supplier shall submit to the Purchaser descriptions of all nameplates, labels and instruction plates for comment.

The transformer nameplate shall be of stainless steel with black enamel lettering.

Nameplates attached to control cabinets, control boards, cubicles and control boxes shall be made of acrylic resin (white letters on black background).

TS.03.18 Shop Tests

The transformer shall be tested at the Supplier's works in accordance with ANSI requirements for routine and type tests. At least 3 weeks notice of the date, time and place of all tests shall be given to the Purchaser so that arrangements can be made to witness the tests.

In addition to the requirements of ANSI the following tests on each transformer shall be performed and witnessed by the Purchaser. The total cost for carrying out these tests, inclusive of the cost of all expenses including air fares, hotel transfers and accommodations paid for two (2) of the

Purchaser's engineers to witness such tests, shall be included in the quoted CIF cost for the transformer to be tested in 2021.

(a) Impulse voltage withstand tests, including chopped waves.

(b) Heat run test.

(c) Core insulation test. Insulation resistance shall be measured at 1000 V and shall indicate a minimum resistance of 50 MΩ to ground. These tests on the transformer shall be made at completion of winding and at the conclusion of all other tests, prior to shipment.

(d) Partial discharge tests shall be as per IEC standards. Note: 12.2, 12.3, and 12.4 as quoted.

(e) Pressure tests at 35 kPa for a duration of 6 hours shall be made on the transformer immediately following the temperature rise test while the oil is hot.

(f) Sweep Frequency Test

(g) Insulation Diagnostic Analysis Test

The Supplier shall supply three certified copies of all analysis and test results. If the Supplier can show, by certified test data obtained from type tests on a transformer of the same design, these tests, (except those specifically required above), may be waived by the Purchaser at its discretion, but such waiver shall in no way relieve the Supplier from its obligations under the Contract.

The test report shall be supplied prior to delivery, but no longer than 2 weeks after completion of the tests.

TS.03.19 Performance Guarantees

Subject to the allowable tolerances stated in ANSI the manufacturer shall guarantee the performance data as provided in Part 6 "Schedule of Technical Data" covering the following:

- No load losses and load losses at rated conditions
- Exciting current
- Impedance at base (ONAN) rating at rated conditions

TS.03.20 Spares

An itemized price for the following spare parts shall be provided.

- One high voltage bushing complete with gaskets
- One low voltage bushing complete with gaskets
- One neutral bushing complete with gaskets
- One set of spare gasket complete with gasket cement
- One refill for dehydrating breather
- One pressure relief device
- One set of indicators and detectors
- One set of fixed and movable tap changer contacts.
- One tap changer motor

The bidder shall recommend any additional spares considered necessary for the satisfactory operation and maintenance of the transformer for a period of five years.

TS.03.21 Oil

Oil shall be mineral oil specifically designed for use as an insulating and cooling medium for electrical equipment and conform to the requirements of ASTM Standard Specification D3487. The PCB content of the oil shall be not more than 2 ppm. The supplier must furnished a certificate duly signed by an independent approval body in the Supplier's country indicating the PBC content of the oil.

A sufficient quantity of oil, plus an additional 10% to allow for spillage shall be supplied to fill the transformer and all accessories. Oil shall be supplied in non-returnable 45 gallon drums.

TS.03.22 Dimensions

The dimensions of the transformer shall not exceed the following;

	Package 1
Height	5,400 mm - overall
Length	3,300 mm – for the tank only
Width	3,200 mm – overall

Failure to submit dimensions with Bid shall result in rejection of Bid.

PART 2

SCHEDULES

Table of Contents

Schedules

SCH.01 Schedule of Requirements

One (1) 7.5 MVA, 69 – 6.9 kV Generator step-up transformer OA/FA, 3 phase, 50 Hz, rated for 65^{0}C rise, completed with all necessary auxiliary equipment, insulating oil for first filling, air cooling radiators and fans, all as specified herein.

SCH.02 Schedules of Information

SCH.02.1 Financial Data

The Bidder attaches the following information concerning his financial resources and previous experience in order to fully demonstrate his ability to undertake the Works:

SCH.02.2 Addenda to Bid Documents

The Bidder has received the following Addenda to the Bid Documents prior to submission of this Bid.

ADDENDA NO. DATED

Name of Bidder _____

Signature of Bidder _____

SCH.02.3 **Deviations from Specification**

The deviations from the Specification are as follows:

SCH.02.4 **Appendices to Bid**

The appendices which form an integral part of the Bid are as follows:

Appendix A - Tender Drawings

Name of Bidder _____

Signature of Bidder _____

SCH.02.5 **Sub-Contracted Work**

Sub-suppliers may be used to supply the following materials and services:

SCH.02.6 **Change in Quantities**

The maximum percent (%) change in quantities allowable within quoted rates is: ……..

For and on behalf of

_____

(Supplier's name)

_____

_____

Title

Name of Bidder _____

Signature of Bidder _____

SCH.03 SCHEDULE OF PRICES

SCH.03.1 Generator Step-up Transformer 7.5 MVA, 69 – 6.9 kV

Bidder shall provide the price for the equipment specified in SCH.01 Schedule of Requirements.

_____ex-works/CIF Currency of Bid _____

Inland Transportation _____

Port Costs, Insurance

Name of Bidder_____

_____

Signature of Bidder _____

SCH.03.2 Spare Parts

Bidder shall provide separate prices for the spare parts listed in section TS.02.20 of these specifications, which shall be supplied as part of this contract.

Item No.	Parts Description	Unit Quantity	Price

Total CIF Cost of Required Spare Parts _____

Recommended Spare Parts

Bidder shall list here with unit prices, any additional spare parts and special tools it recommends for continuous operation of the plant for a period of 5 years.

SCH.04 SCHEDULE OF DELIVERIES

Generator Step-up Transformer **One (1) – 7.5 MVA**

Purchaser's Required Delivery: Six (6) months A.R.O

Supplier's Proposed Delivery: _____

Name of Bidder: _____

Signature of Bidder: _____

SCH.05 Schedule of Technical Data

SCH.05.1 Materials and Workmanship

The Supplier guarantees that the equipment/material furnished hereunder will be entirely suitable for the service specified, will conform to all conditions of performance and design, be free from manufacturing and material defects.

The Supplier also guarantees that he will at the convenience of and without charge to the Purchaser replace, repair and install any of the Works or part thereof which prove defective as a result of faulty design, materials or workmanship, in accordance with the warranty requirements stated in section SC-10 of this specification.

Item One: 7.5 MVA, 69 – 6.9 kV GSU Power Transformer

(a) Guaranteed Performance and Characteristics

1. Capacity, at rated voltage, frequency, continuous rating, at 65 ^{0} C temperature rise by resistance method.

- AN base rating.	_____MVA
- AF rating.	_____MVA

2. Efficiency at rated voltage and frequency not less than

- at 50% MVA @ 1.0 pf	_____ %
- at 75% MVA @ 1.0 pf	_____ %
- at 100% MVA @ 1.0 pf	_____ %
- at 125% MVA @ 1.0 pf	_____ %

3. Efficiency at rated voltage and frequency not less than

- at 50% MVA @ 0.8 pf	_____ %
- at 75% MVA @ 0.8 pf	_____ %
- at 100% MVA @ 0.8 pf	_____ %
- at 125% MVA @ 0.8 pf	_____ %

4. Guaranteed Losses rated voltage and frequency, 65 ^{0} C temp. rise

- no load loss	_____ kw
- load loss at rated MVA	_____ kw
- excluding no load loss	_____ kw
- Total losses (rated MVA)	_____ kw

5. Cooling Equipment power at 65 ^{0} C temp. rise and full MVA, _____ kw

6. Exciting current on base MVA

- at 90% rated voltage	_____ %
- at 100% rated voltage	_____ %
- at 110% rated voltage	_____ %

7. Regulation, not more than, at
   100% MVA, 0.8 pf for 65°C rise _____ %
   100% MVA, 1.0 pf for 65°C rise _____ %

8. Impedance on base MVA, at rated voltage and frequency, subject to ANSI tolerances.
   - rated voltage _____ %
   - maximum raise _____ %
   - maximum lower _____ %

9. Maximum Temperature Rise by resistance measurement
   - AN _____°C
   - AN/AF _____°C

10. Guaranteed Noise Level
    - with fans _____ dB
    - without fans _____ dB

(b) Technical Data

1. Manufacturer _____

2. Frequency _____ Hz

3. Voltage & Connection and Vector Grouping
   HV winding _____
   LV winding _____
   Vector Group _____

4. Insulation Level (LIWL)

   HV winding _____ kV
   LV winding _____ kV
   LV neutral _____ kV

5. Tap Changer
   Type _____
   Manufacturer _____
   Tap range _____ %
   Number and % of taps _____

6. C.T. Ratios, Accuracy and Number per bushing

HV bushings	_____
HV neutral bushings	_____
LV bushings	_____

7. Bushing Creepage Distance

High Voltage	_____ mm
Low Voltage	_____ mm
Low Voltage Neutral	_____ mm

8. Weights

- Assembled transformer in service	_____ kg
- Shipping wt. of heaviest part	_____ kg
- Core and coils (Untanking)	_____ kg
- Tank	_____ kg
- Oil	_____ kg

9. Material of winding _____

10. Provide drawing showing assembled dimensions of transformer as well as shipping dimensions and lifting clearances for untanking and removal of bushings.

11. Oil

- PCB content	_____ ppm

12. Dimensions:

Height	_____mm
Length	_____mm
Width	_____mm

13. Any other information specifically requested, or which may be useful to the Purchaser:

SCH.05.3 **SURGE ARRESTERS**

Technical Data

1.	Nominal System Voltage	69kV	6.9kV
2.	Manufacturer	_____	_____
3.	Type	_____	_____
4.	Rated Frequency	_____Hz	_____Hz
5.	System Grounding	Effective Soild	UnGrd
6.	Maximum continuous operating voltage (mcov)	_____kV	_____kV
7.	Maximum temporary overvoltage	_____kV	_____kV
8.	Maximum 0.5 μs discharge voltage	_____kV	_____kV
9.	Maximum switching surge protective level - 45 μs to crest	_____kV	_____kV
10.	Maximum discharge voltage 5,000 amp crest	_____kV	_____kV
	10,000 amp crest	_____kV	_____kV
	20,000 amp crest	_____kV	_____kV
11.	Weights	_____	_____

12. Any other information specifically requested, or which may be useful to the Purchaser.