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NATION RELIGION KING

ELECTRICITE DU CAMBODGE

TECHNICAL SPECIFICATION

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22 kV Three-Phase Indoor Distribution Transformers

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Version 2: Modifications from version 1 (February 2017):

- All transformer of hermetically sealed type
- Modification of thermometer range and max/min ambient temperatures
- Introduce CB protection for 800 kVA transformer
- Add Gas detection for transformer of 1000 kVA and more
- Clarification on LV bushings
- Correction of minor typing mistakes

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22 kV Three-Phase Indoor Distribution Transformers

1 Scope

This specification covers the design, manufacturing, testing, supply, delivery and performance requirements 3-phase, oil immersed, hermetically sealed indoor distribution transformers for 22 kV level to be used on the power distribution networks of EDC with a life expectancy of at least 25 years without any maintenance in normal conditions.

2 Standards

IEC : International Electro-technical Commission

- IEC 60071 : Insulation co-ordination
- IEC 60076-SER : Power transformers - all parts
- IEC 60296 : Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear

EN : European Standards

- EN 50180 : Bushings above 1 kV up to 52 kV and from 250 A to 3.15 kA for liquid filled transformers
- EN 50387 : Busbar bushings up to 1 kV and from 1.25 kA to 5 kA, for liquid filled transformers

ISO : International Standard Organization

- ISO 2063 : Metallic coating-protection of iron and steel against corrosion
- ISO/IEC 17025 : General requirements for the competence of testing and calibration laboratories
- ISO 9001 : Quality management systems – Requirements

Unless if standard year is specified, the latest version of the above standards apply.

The supplier may propose alternative standards, provided it is demonstrated that they give an equivalent degree of quality as the referenced standard. Acceptability of any alternative standard is at the discretion of the EDC.

3 Definitions

The definition of the relevant IEC standards applies to this technical specification.

4 Testing and Inspection

4.1 General Notes for Test

Transformers may be inspected at the manufacturer's factory by EDC's representatives.

The inspection and routine tests shall be carried out in accordance with the provisions of the relevant IEC 60076 recommendations.

The transformers shall be subjected to test as specified below.

4.2 Type Tests

All type tests required by the IEC 60076 shall be carried out.

Type test reports shall be carried out by internationally recognized electrical testing laboratories.

Full copies of type test reports shall be submitted within the bid of the manufacturer/supplier. Type test reports older than 10 years will not be accepted.

If the manufacturer is certified by EDC, it is not necessary to submit type test reports for the considered equipment.

Nevertheless, in case the testing laboratory is not internationally recognized, the testing laboratory shall be mandatorily accredited ISO/IEC 17025 by an international or national accreditation body specialized in testing laboratories accreditation/acceptance. In that case, the testing laboratory shall prove mandatorily its capability/capacity to carry out all type tests mentioned in the type tests reports by supplying: Full description of all tests the laboratory can carry out, list of testing equipment with full characteristics, drawing of testing rooms with location of testing equipment etc., supported by pictures and copy of the ISO/IEC 17025 accreditation certificate.

Acceptability of any accredited testing laboratory is at the discretion of the EDC.

4.3 Routine Tests

The routine tests requested by IEC 60076 shall carried out on all transformers. Routine test reports shall be sent to EDC prior the shipment for EDC acceptance.

The routine test report shall be also attached to each transformer in a fully waterproof pocket or under the form of an indelible plastic sheet.

The routine testing procedure to be carried out during EDC approval inspection shall be sent to EDC for approval.

4.3.1 Oil routine tests

Oil will be routine tested and analyzed to prove PCB free and the routine test report shall be sent to EDC prior the shipment for acceptance.

5 Quality Management

Design, development and production of the proposed equipment shall be ISO 9001 certified. The ISO 9001 certificate shall be submitted within the bid.

6 Technical Requirements

6.1 General

22 kV Distribution Transformers shall be 3-phase, 2 windings, oil immersed, 50 Hz and shall have off circuit tapings mounted in the primary winding. The type of cooling shall be oil natural air natural (ONAN).

6.2 Primary Voltage Rating

The transformers to be supplied will have the following primary rating:

- 22 kV Transformers : Un: 22 kV, Um : 24 kV

7 Performance Characteristics

7.1 Ambient Conditions

The transformers shall be suitable to operate in the ambient conditions described here after:

Altitude	Sea level to 1,000 meters
Climate	Tropical
Annual Rainfall	1,300 mm.140 days
Monsoon Period	June to November
Ambient Air Temperatures:	
Average	27.5°C
Minimum	13.3°C
Maximum	40.5°C
Relative Air Humidity	65-100%
Soil Thermal Resistivity:	
Average	1.20 cm/W
Maximum	3.00 cm/W
Solar Emissivity	0.8
Solar absorption	0.8
Wind Velocity:	
Average	37 km/h (10.3 m/s)
Maximum	72 km/h (20 m/s)

7.2 Rated Capacity

The continuous rating of the Distribution Transformers shall be:

Primary Voltage	Secondary Voltage	Rated Capacity (kVA)
22 kV	230/400 V	100, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3000

All transformers shall be of indoor type, designed for building or prefabricated substation.

Each transformer shall be capable of supplying its rated capacity continuously for all tap positions with rated voltage on the secondary winding and continuous, steady load, a maximum temperature gradient of 21 °C and maximum winding hot spot of 98 °C. The transformers shall also be capable of delivering rated current at an applied voltage equal to 110 % of the rated voltage.

Likewise, each transformer shall be capable of supplying its rated capacity continuously under ambient temperature conditions without the temperature rise of the top oil exceeding 55 °C and without the temperature rise of the windings as measured by resistance exceeding 60 °C. The ambient temperature conditions will be as follows:

- Maximum ambient temperature: 40.5 °C
- Maximum monthly average temperature: 35 °C
- Annual average temperature: 27.5 °C

7.2.1 Overload capacity

In addition, after thermal equilibrium has been reached at 75% of rated load, the transformers shall be capable of sustaining the overload conditions listed below, without the transformer winding hot spot temperature exceeding 140°C.

Load	Minimum duration in minutes	
Percentage of rated load	Ambient temperature: 30 °C	Ambient temperature: 40 °C
120%	480	240
133 %	240	115
150 %	98	65

The supplier shall include calculations demonstrating that these requirements are met. These calculations shall disregard the effect of winding thermal capacity.

Importance is attached to overload capacity and transformers incapable of meeting the performance specified shall not be considered and accepted.

8 Technical Characteristics

8.1 Off-Load Tap Changer

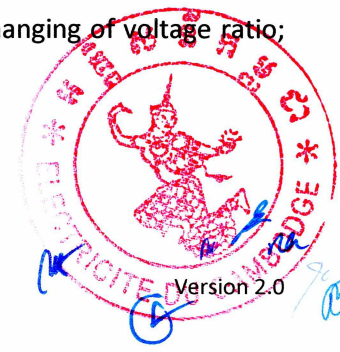
The high voltage windings shall be provided with off-load tap changer for voltage adjustment.

The lever for operating the off-load tap changer shall be of externally operated type.

8.1.1 Voltage ratio

Each transformer shall be fitted with 5 taps giving provision for off circuit changing of voltage ratio;
The tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%,

The no load voltage ratios shall be:



Tap Number	Secondary Voltage 3-phase transformer	Primary Voltage for 22 kV winding
1	400 V	23 100 V
2	400 V	22 550 V
3	400 V	22 000 V
4	400 V	21 450 V
5	400 V	20 900 V

8.1.2 Tapping method

Tap changing shall be carried out with the transformer off circuit. An externally operated self-positioning tapping switch shall be provided. The handle shall give visual indication of the tapping position, and it shall be rotated in clockwise direction from a high tap to lower tap "1" to "5". Switch position No.1 shall correspond to the primary voltage that gives the highest voltage ratio.

The tap position shall be indelibly marked by embossing or engraving and with weather proof paint and in color which shall present distinctive contrast to the surrounding material. The operating handles shall be made by non-corrosive metal.

Provision shall be made for locking of the tapping switch handles in any desired position, with a 6 mm standard diameter hasp lock to be provided by EDC.

Tap change switches shall be fitted with gaskets and covers in order to make the sealing of the transformer independent of the switch shaft gland under normal conditions.

8.2 Core

Core shall be made of low loss; high permeability material and the core construction shall avoid static discharge and development of short-circuit paths within itself or to the ground. The core design shall ensure no hot sections due to over fluxing or circulating currents. The flux density at any point shall designed to meet 1.55 to 1.65 tesla.

8.3 Winding

MV and LV Windings shall be made with high conductivity copper and shall be designed and manufactured to resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit. The insulation material of windings shall be suitable for the specified temperature rise and shall be thermally stabilized.

8.3.1 Connections and vector group

The vector group of all distribution transformers shall be Dyn11 in accordance with IEC 60076.

8.4 Insulation Levels

Power transformers shall be designed according the recommendations of IEC 60071-SER and tested to the following insulation levels:

Service Voltage	Rated Maximum Voltage	Power frequency withstand voltage (50Hz/1 mn)	Rated impulse withstand voltage (1.2/50µs)
22 kV	24 kV	50 kV	125 kV
0.4 kV	1 kV	3 kV	NA

The windings shall be fully insulated and the neutral point shall be insulated for full voltage.

8.5 Impedance Voltage, Uk%

The impedance on the principal tap (tap 3) shall be: 4% for transformers up to 630 kVA, 5% up to 1250 kVA and 6% for higher capacity. The impedance voltage shall be subject to the tolerance specified in IEC 60076.

Impedance Voltage (Uk%)	Transformer capacity (kVA)
4%	100, 160, 200, 250, 315, 400, 500, 630
5%	800, 1000, 1250
6%	1600, 2000, 2500, 3000

Transformers shall have corresponding impedance per tap characteristics such that transformers of the same rating can be operated in parallel.

8.6 Short-circuit Performance

The transformer shall be capable of sustaining a three-phase symmetrical short circuit on the low voltage side with power maintained on the high voltage side without damage or distress for 3 seconds.

According to IEC 60076-SER, all transformers shall have:

- a thermal withstanding to short circuit of 2 s.
- a mechanical withstanding to short circuit of 0.5 s with I = I rated x 100 / Uk%,

Where Uk% is the impedance voltage.

8.7 Losses

According to Cambodia and EDC Standards for 22 KV distribution transformers, maximum values of losses accepted shall be as follows:

3-phase 22 kV Transformers		
Transformer Capacity (kVA)	No-load Loss (W)	Load Loss at 75 °C (W)
100	≤ 250	≤ 1 550
160	≤ 360	≤ 2 100
200	≤ 450	≤ 2 500
250	≤ 500	≤ 2 950
315	≤ 600	≤ 3 500
400	≤ 720	≤ 4 150
500	≤ 860	≤ 4 950
630	≤ 1 010	≤ 5 850
800	≤ 1 200	≤ 9 900
1000	≤ 1 270	≤ 12 150
1250	≤ 1 500	≤ 14 850
1600	≤ 1 820	≤ 17 850
2000	≤ 2 110	≤ 21 600
2500	≤ 2 600	≤ 25 500
3000	≤ 3 000	≤ 33 000

The losses shall be stated and guaranteed in the offer. The guaranteed losses are to be maximum values and shall not be exceeded.

If at delivery, the tested losses exceed the guaranteed losses, the transformer will be rejected.

There will be no credit for losses less than the guarantee.

8.8 Regulation

The supplier shall guarantee that the regulation of each transformer from no load to continuous rated output at 1.0 power factor and at 0.85 lagging power factor shall be as stated in the technical data schedules.

8.9 Over Fluxing

The transformer shall be capable of operating continuously with rated current and with system maximum voltage applied to the secondary winding at a frequency of 96 % of rated frequency without exceeding the temperature rise specified before.

For all transformers, the limit of flux density at any point in the magnetic circuit shall be subject to the requirements for losses, harmonics and noise suppression.

8.10 Acoustic Sound Level

The acoustic sound level shall be measured according to the IEC 60076 requirements.

It shall be not exceeded:

Transformer Capacity (kVA)	Max Acoustic Sound Level: dB(A)
100	55
160	57
200	59
250	60
315	62
400	63
500	64
630	65
800	66
1000	68
1250	69
1600	71
2000	73
2500	76
3000	80

Transformers that exceed the tolerances allowed by IEC 60076 will be rejected.

9 Materials and Construction

9.1 Tank and Cover

Tank and cover shall be constructed of welded steel sheets. The joints between tank and cover shall be provided with suitable flanges bolted together with gaskets.

The cover shall be formed of steel sheet and electrically bonded to the tank. It shall be designed in such manner the tank/cover gasket remains in correct position during assembly and all along the transformer lifespan.

The transformer tank shall be designed in such a manner that the completed transformer can be lifted and transported without permanent deformation or oil leakage.

The tank and cover shall be designed in such a manner to prevent external pockets in which water can lodge.

All pipes, fins or corrugation shall be externally welded to the tank wall.

9.2 Sealing

The transformer tank shall be sealed by means of suitable gasket or welding. The tank cover shall be removable for core and coils access. Transformer parts inside the tank shall be able to remove upward in one piece with the lift of the tank cover.

All gaskets shall be made of resilient material which will not deteriorate under the action of hot oil and will remain oil-tight for the life expectancy of the transformer.

All gaskets and sealing devices shall be able to maintain the seal for extreme operating temperatures of the transformer.

9.3 Oil Preservation System

The oil preservation system of the transformers shall be of the following type according the requirement of IEC 60076-1 paragraph 8.2.

- Sealed, completely filled system in which the expansion of the oil is taken up by elastic movement of the permanently sealed, usually corrugated tank.

9.4 Cooling

The tank shall be designed for natural cooling (ONAN) with a corrugated wall tank if additional cooling is required.

9.5 Transformer Lifting

Each transformer shall be provided with a minimum of two closed lifting lugs located on the transformer cover. The minimum diameter of the hole shall be 25 mm. The two lifting lugs shall be located such that there will be a minimum of 50 mm between the lifting chain and the nearest part of the LV bushings.

9.6 Under Frame

Three-phase Transformer shall be fitted with an under frame suitable for supporting the transformer on a flat surface.

9.6.1 Wheels

The under frame shall be fitted with four metallic wheels conform to the requirement of EN 50216-4 standard. Those wheels shall be strong enough for supporting the transformer.

In order to facilitate the transformer installation in a distribution substation, the four wheels shall be orientable in 360 °. In addition, all the wheels shall be lockable by means of bolts or equivalent system in the longitudinal and transverse direction of the transformer (90 °).

9.7 Filling and Draining

A filling stub with an inner diameter of at least 25 mm shall be placed at the top of the cover. Transformers shall have a 25 mm (at least) BSP oil drain plug placed at the bottom of the tank.

9.8 Earthing

Two 10 mm diameter holes for connection of earth wires copper lug shall be provided on the transformer under frame. Those holes shall be located one on each lower side of the transformer.

In addition, the two lifting lugs shall be also fitted with one 10 mm diameter hole each.

9.9 Cores and Coils

The core and coil assembly shall have the core and coils rigidly connected to the tank and shall not shift in any direction during shipping, transportation, installation and operation.

The core construction shall avoid static discharge and development of short-circuit paths within itself or to the ground.

The windings shall be designed and manufactured to resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.

9.10 Accessories

9.10.1 Overpressure relief device

The transformers shall be equipped with an overpressure relief device. The overpressure relief device shall be covered with a suitable "cover" to protect persons in the vicinity of the transformer against the spurting of hot oil in the event of an internal fault of the transformer.

9.10.2 Thermometer pocket

The transformers shall be equipped at the top with a pocket for a thermometer to measure the oil temperature. The transformer pocket shall be welded on the transformer lid.

The transformer shall be supplied with the thermometer pocket filled with oil and the thermometer installed shall be of 2 pointers with the maximum temperature indicator of resettable type with horizontal reading scale graduated in °C.

The thermometer screen shall also include switch setting indicators.

The technical characteristics of the thermometer shall be as follow:

Mounting	Top mounted
Range (°C)	20 to 120
Accuracy	± 2%
Ambient operating temperature (°C)	0 to 60
Protective index (IEC 60529)	IP 55
Number of switches	2 (adjustable)
Max switches current	5 Amp
Switches accuracy	± 3%
Dielectric insulation	2000V AC /1mn

The lens of the thermometer shall be made of UV resistant polycarbonate.

9.10.3 Gas detection device.

Transformer with a capacity of 800 kVA and more shall be fitted with a gas detection device installed on the transformer top cover.

This device shall include as a minimum

- a gas accumulation tank with visible level with a change-over contact (NO,NC, Common)
- excessive pressure with a change-over contact (NO,NC, Common)

The gas pressure device can include the thermometer as required by 9.10.2 clause in the same enclosure

9.10.4 Other accessories

All other transformer necessary accessories shall be supplied with the transformer.

9.11 Surface Treatment

Transformers and smaller parts such as brackets, etc. shall be powder painting with Dark Grey colour-RAL 7033 or 7036.

As an alternative to powder painting the exterior of the tank of the transformers may be painted with a primer coat and not less than two-finish epoxy or acrylic paint coats provided the manufacturer prove a surface treatment lifespan that meet the lifespan of the transformer (25 years without maintenance) by providing salt spray test or equivalent.

The inner surfaces of the tank and radiators shall be coated by an oil resistant paint.

Before painting the interior and exterior of the tank in a dismantled condition shall be abrasive blast cleaned to white metal. All surfaces (except those in direct contact with oil) immediately after cleaning and not less than four hours after cleaning shall be coated with the powder painting.

Before any top coats are applied i.e. before assembly, the coating is to be primed in accordance with the paint manufacturer's recommendations.

The interior of the tank in contact with the oil shall be given at least one coat of non-chipping oil and acid resisting paint or varnish after cleaning as above.

The details of the paint system to be used, including the brand and type of paint to be used shall be included in the Bid documents.

The offer shall include a description of the method of corrosion protection.

10 Bushings

10.1 Primary Bushings

10.1.1 General

All winding leads shall be brought out through epoxy bushings for separable connector. All bushings shall be conformed to the requirement of EN 50180 type A bushings: plug-in pin contact with a current rating of 250 Amperes.

The bushings shall be fitted each with 6 fixing shoes for securing the fixing device of the separable connector.

It shall be possible to change gaskets or insulating parts of the bushing without removing the transformer cover.

10.1.2 Location

Primary bushings shall be located on the transformer cover (Top).

10.1.3 Insulation level

The insulation levels for bushing shall be at least equal to those specified for the windings.

10.1.4 Protecting covers

Plug in bushing shall be protected by a UV resistant plastic cover for storage and transportation.

10.2 Secondary Bushings

10.2.1 General

Distribution transformer with a capacity of less than 250 kVA shall be supplied with porcelain bushings. Porcelain bushings include porcelain insulator and copper terminal.

The transformers of 250 kVA or more shall be fitted with busbar bushings or porcelain bushing fitted with pads.

10.2.2 Location

The LV bushing, either porcelain or busbar bushings shall be located and aligned on the tank cover.

10.2.3 Electrical Characteristics

Rated maximum voltage: 1 kV

Withstand voltage at power frequency 50 Hz: 3 kV (1 mn)

10.2.4 Construction

10.2.4.1 Porcelain bushings

The porcelain shall be tested according to IEC Publication 60137 or equivalent standard respectively. The glaze shall be brown and shall cover all exposed parts of the insulator. Between the porcelain and surrounding metal, gaskets or cement are to be interposed. All porcelain clamping surfaces in contact with gaskets shall be accurately grounded and free from glaze.

Each porcelain bushing shall be marked with manufacturer's identification mark, indicating the year of manufacturing and other marks necessary for the tests. The marking shall be clearly legible and visible after assembly of the fittings.

Connections from the windings to the bushings shall have necessary length and flexibility.

Porcelain bushing shall fit with pads.

10.2.4.2 Busbar bushings

Busbar bushing shall be designed and tested according EN 50387. The materials used for busbar bushings shall be fully compatible with the insulating oil. The material and the tightness of busbar bushings shall allow outdoor storage of transformers where the temperature can vary from 15°C to 50°C and under heavy rain.

Phase and neutral busbar bushing shall be identical.

It must be possible to change gaskets or insulating parts of the busbar bushing without removing the transformer cover. Connections from the windings to the bushings shall have necessary length and flexibility

The bar shall be made of hot tinned pure copper. The tin thickness shall not be less of 8 microns (µm). Bar cross section shall be chosen in accordance with the maximum secondary current of the transformer.

The bar shall be drilled in accordance with NEMA or EN 50387 or EDF HN 52S62 standards or any equivalent standard provided it shall be possible to connect copper insulated 1x240mm² cables fitted with compression lugs with a 13mm diameter hole.

10.2.4.3 LV terminals and cable connection

Threaded parts and screws shall be of metric sizes. External terminals (bars or pads) shall be suitable to received compression 240 mm² copper lugs insulated conductor with a hole of 13 mm diameter.

The number of cables to be connected to bars or pads shall be as follow:

Transformer Capacity	LV terminals and cable connection
100, 160, 200 and 250 kVA	One (1) cable for each phase and neutral
315, 400 kVA	Two (2) cables for each phase and one cable for neutral
500, 630 kVA	Three (3) cables for each phase and two cables for neutral
800, 1000 kVA	Four (4) cables for each phase and two cables for neutral
1250 kVA	Five (5) cables for each phase and two cables for neutral
1600 kVA	Six (6) cables for each phase and three cables for neutral
2000 kVA	Eight (8) cables for each phase and four cables for neutral
2500 kVA	Ten (10) cables for each phase and five cables for neutral
3000 kVA	Twelve (12) cables for each phase and six cables for neutral

Each hole shall be fitted with one M12x60mm stainless steel or copper bolt including one nut, two flat washers and one lock washer (or the nut must be of self-lock type).

10.2.5 LV bushings insulating box (OPTION)

The LV bushings and the connections shall be protected by and insulating box that shall provide a protective index of IP2X except rear face.

This LV bushing insulation box is a transformer option that shall be requested at tender time.

10.3 Terminal Marking

The terminal markings shall be clearly and permanently displayed. Painted markings are not acceptable.

The distribution transformers shall be labelled as follows:

Primary voltage: A, B, C

Secondary voltage: a, b, c and n

11 Label and Rating Plates

Labels, plates, markings and instructions shall be clear and indelible and both in English and Khmer language. Case-in or molded-in words which are not English words shall be covered with permanently fixed non-ferrous labels inscribed in English.

A weatherproof rating plate shall be provided in accordance with IEC 60076 and showing the following items, indelibly marked by engraving or embossing:

Type of transformer,
Specification to which standard it was manufactured,
Manufacturer's name,

Serial number,
Year of manufacturing,
Number of phases,
Rated capacity,
Rated frequency,
Rated voltages,
Rated currents,
Vector group,
Percentage impedance voltage at rated current,
Type of cooling,
Continuous ambient temperature at which ratings apply,
Top oil temperature rises at rated load,
Total weight,
Volume of oil,
Weight of core and windings,
Table of primary voltages at the 5 tapping positions,
Connection diagram.
Property of ELECTRICITE DU CAMBODGE and EDC logo "កម្មសិទ្ធិអគ្គិសនីកម្ពុជា"

It shall be possible to fix this plate on all side of the transformer with exception of the LV bushing side.

In addition, a second plate or paint marking mentioning kVA rating in numerals 70 mm height shall appear on the tank and below the MV bushing. These numerals shall be applied by stenciling or by other suitable means.

12 Oil

All transformers shall be filled to the required level with new, unused, clean, standard mineral oil in compliance with IEC 60296 and shall be free from all traces of polychlorinated biphenyl (PCB) compounds.

The oil shall be PCB free; EDC will refuse the delivery of the transformers that are not proved to comply with this requirement.

Oil suppliers coordinates, oil type, reference and detailed characteristics shall be provided in the offer.

13 Delivery

Transformers shall be delivered suitably protected for transport and storage on a strong enough non-returnable wooden case pallet.

14 Technical Data Sheets

No.	Descriptions	Unit	Requirement	Supplier's Offer
	22 kV Three-phase indoor transformers		100 kVA ☐ 160 kVA ☐ 200 kVA ☐ 250 kVA ☐ 315 kVA ☐ 400 kVA ☐ 500 kVA ☐ 630 kVA ☐ 800 kVA ☐ 1000 kVA ☐ 1250 kVA ☐ 1600 kVA ☐ 2000 kVA ☐ 2500 kVA ☐ 3000 kVA ☐	
1	Country		to be specified	
2	Manufacturer		to be specified	
3	Manufacturer's reference		to be specified	
4	Standard		IEC 60076	
5	Type test reports as per § 4.2 and IEC 60076		To be provided	
6	ISO 9001 for design, development and production		Yes. Certificate to be provided	
I.	**General**			
a.	Indoor installation and operation on MV distribution network with nominal voltage 12.7/22 kV, 50 Hz with the life expectancy of at least 25 years.		Yes	
b.	Oil-immersed transformers, self-cooled (ONAN), two winding, and three phase type.		Yes	
c.	Ambient condition as per § 7.1		Yes	
d.	Overload capacity		To be specified	
II.	**Construction and physical characteristics**			

1.	**Tank**			
a.	Tank and cover are constructed of welded steel sheets. The joints between tank and cover provided with suitable flanges bolted together with gaskets.		Yes	
b.	The cover is formed of steel sheet and electrically bonded to the tank. It is designed in such manner the tank/cover gasket remains in correct position during assembly and all along the transformer lifespan		Yes	
c.	The transformer tank is designed in such a manner that the completed transformer can be lifted and transported without permanent deformation or oil leakage.		Yes	
d.	The tank and cover are designed in such a manner to prevent external pockets in which water can lodge.		Yes	
e.	All pipes, fins or corrugation are externally welded to the tank wall.		Yes	
2.	**Sealing**			
a.	The transformer tank is sealed by means of suitable gasket.		Yes	
b.	The tank cover is removable for core and coils access.		Yes	
c.	Transformer parts inside the tank are able to remove upward in one piece with the lift of the tank cover.		Yes	
d.	All gaskets are made of resilient material which will not deteriorate under the action of hot oil and will remain oil-tight for the life expectancy of the transformer.		Yes	
e.	All gaskets and sealing devices are able to maintain the seal for extreme operating temperatures of the transformer.		Yes	
3.	**Oil preservation system**			
a.	Transformer are hermetically sealed, completely filled system type in which the expansion of the oil is taken up by elastic movement of the permanently sealed, usually corrugated tank.		Yes	

b.	The tank is designed for natural cooling (ONAN) with a corrugated wall tank if additional cooling is required.		Yes	
c.	Each transformer is provided with a minimum of two closed lifting lugs located on the transformer cover. The minimum diameter of the hole shall be 25 mm. The two lifting lugs shall be located such that there will be a minimum of 50 mm between the lifting chain and the nearest part of the LV bushings.		Yes	
d.	Three-phase transformer is fitted with an under frame suitable for supporting the transformer on a flat surface.		Yes	
e.	The under frame is fitted with four metallic wheels conform to the requirement of EN 50216-4 standard. Those wheels shall be strong enough for supporting the transformer.		Yes	
f.	The four wheels are orientable in 360 °. All the wheels are lockable by means of bolts in the longitudinal and transverse direction of the transformer (90 °).		Yes	
g.	Filling stub inner and drain plug diameter		≥ 25 mm	
4.	**Cores and coils**			
a.	The core and coil assembly have the core and coils rigidly connected to the tank and shall not shift in any direction during shipping, transportation, installation and operation.		Yes	
b.	The core construction avoids static discharge and development of short-circuit paths within itself or to the ground.		Yes	
c.	Cores are made of low loss, high permeability material		Yes	
d.	The core design ensures no hot sections due to over fluxing or circulating currents. The flux density at any point shall designed to meet 1.55 to 1.65 tesla.	Tesla	To be specified	
e.	The windings are designed and manufactured to resist, without suffering		Yes	

	damage, the thermal and mechanical effects caused by external short-circuit.			
f.	MV and LV Windings are made with high conductivity copper and shall resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
g.	The insulation material of windings is suitable for the specified temperature rise and shall be thermally stabilized.		Yes	
h.	Vector group		Dyn 11 (IEC 60076)	
4.1	**Primary**			
a.	Service voltage (Un)	kV	22	
b.	Rated maximum voltage (Um)	kV	24	
c.	Power frequency withstand voltage (1 mn)	kV	50	
d.	Rated impulse Voltage (1.2/50µs)	kV	125	
e.	Frequency	Hz	50	
4.2	**Secondary**			
a.	Service voltage (Un)	kV	0.4	
b.	Rated Maximum Voltage (Um)	kV	1	
c.	Power frequency withstand voltage (1 mn)	kV	3	
5.	**Impedance voltage on the principal tap (tap 3) :**			
a.	transformers up to 630 kVA		4%	
b.	From 800 up to 1250 kVA		5%	
c.	From 1600 kVA up to 3000 kVA		6%	
d.	The impedance voltage is subject to the tolerance specified in IEC 60076.		Yes	
6.	**Short circuit performance § 8.6**			
a.	Sustaining a three-phase symmetrical short circuit on the low voltage side with power maintained on the high voltage side without damage or distress for 3 seconds.		Yes	
b.	Thermal withstanding to short circuit of 2 s.		To be specified	
c.	Mechanical withstanding to short circuit of 0.5 s with I = I rated x 100 / Uk%,		To be specified	

7.	**Tap changer § 8.1**			
a.	The high voltage windings are provided with off-load tap changer for voltage adjustment		Yes	
b.	The lever for operating the off-load tap changer is of externally operated type and shall be made by non-corrosive metal.		Yes	
c.	The tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%,		Yes	
d.	The handle gives visual indication of the tapping position, and it shall be rotated in clockwise direction from a high tap to lower tap "1" to "5". Switch position No.1 shall correspond to the primary voltage that gives the highest voltage ratio.		Yes	
e.	The tap position is indelibly marked by embossing or engraving and with weather proof paint		Yes	
f.	Provision is made for locking of the tapping switch handles in any desired position, with a 6 mm standard diameter padlock		Yes	
8.	**Losses § 8.7**			To be specified
a.	100 kVA • No load • Load (75°C)	W	• ≤ 250 • ≤ 1 550	
b.	160 kVA • No load • Load (75°C)	W	• ≤ 360 • ≤ 2 100	
c.	200 kVA • No load • Load (75°C)	W	• ≤ 450 • ≤ 2 500	
d.	250 kVA • No load • Load (75°C)	W	• ≤ 500 • ≤ 2 950	
e.	315 kVA • No load • Load (75°C)	W	• ≤ 600 • ≤ 3 500	
f.	400 kVA • No load • Load (75°C)	W	• ≤ 720 • ≤ 4 150	

g.	500 kVA • No load • Load (75°C)	W	• ≤ 860 • ≤ 4 950	
h.	630 kVA • No load • Load (75°C)	W	• ≤ 1 010 • ≤ 5 850	
i.	800 kVA • No load • Load (75°C)	W	• ≤ 1 200 • ≤ 9 900	
j.	1000 kVA • No load • Load (75°C)	W	• ≤ 1 270 • ≤ 12 150	
k.	1250 kVA • No load • Load (75°C)	W	• ≤ 1 500 • ≤ 14 850	
l.	1600 kVA • No load • Load (75°C)	W	• ≤ 1 820 • ≤ 17 850	
m.	2000 kVA • No load • Load (75°C)	W	• ≤ 2 110 • ≤ 2 1600	
n.	2500 kVA • No load • Load (75°C)	W	• ≤ 2 600 • ≤ 25 500	
o.	3000 kVA • No load • Load (75°C)	W	• ≤ 3 000 • ≤ 33 000	
9.	**Acoustic sound Level § 8.10**			To be specified
a.	100 kVA	dB(A)	≤ 55	
b.	160 kVA	dB(A)	≤ 57	
c.	200 kVA	dB(A)	≤ 59	
d.	250 kVA	dB(A)	≤ 60	
e.	315 kVA	dB(A)	≤ 62	
f.	400 KVA	dB(A)	≤ 63	
g.	500 kVA	dB(A)	≤ 64	
h.	630 kVA	dB(A)	≤ 65	
i.	800 kVA	dB(A)	≤ 66	
j.	1000 kVA	dB(A)	≤ 68	

k.	1250 kVA	dB(A)	≤ 69	
l.	1600 kVA	dB(A)	≤ 71	
m.	2000 kVA	dB(A)	≤ 73	
n.	2500 kVA	dB(A)	≤ 76	
o.	3000 kVA	dB(A)	≤ 80	
10.	**Accessories § 9.10**			
a.	The transformers are equipped with an overpressure relief device. The overpressure relief device is covered with a suitable "cover" to protect persons in the vicinity of the transformer against the spurting of hot oil in the event of an internal fault of the transformer		Yes	
b.	The transformers are equipped at the top with a pocket for a thermometer to measure the oil temperature. The transformer pocket is welded on the transformer lid.		Yes	
c.	The transformer is supplied with the thermometer pocket filled with oil and the thermometer installed is of 2 pointers with the maximum temperature indicator of resettable type with horizontal reading scale graduated in °C.		Yes	
d.	Thermometer Switches setting indicators.		Yes	
e.	Thermometer technical characteristics -Mounting -Range (°C) -Accuracy -Ambient operating temperature (°C) -Protective index (IEC 60529) -Number of switches -Max switches current -Switches accuracy -Dielectric insulation		 Top mount 20 to 120 ± 2% 0 to 60 IP 55 2 (adjustable) 5 Amp ± 3% 2000V AC /1mn	
f.	All transformer necessary accessories are supplied with the transformer		Yes	
g	Transformer of 800 kVA and more are fitted with a gas detection device installed on the transformer top cover.		Yes	
	This device includes as a minimum			

	• a gas accumulation tank with visible level with a change-over contact (NO,NC, Common) • excessive pressure with a change-over contact (NO,NC, Common)		Yes Yes	
	The gas pressure device includes the thermometer as required by 9.10.2 clause in the same enclosure		To be mentioned	☐ Yes ☐ No
10.1	**Surface treatment § 9.11**			
a.	Transformers and smaller parts such as brackets, etc. are powder painting with Dark Grey colour-RAL 7033 or 7036 or be painted with a primer coat and not less than two-finish epoxy or acrylic paint coats.		To be clearly mentioned	
b.	The interior of the tank in contact with the oil is given at least one coat of non-chipping oil and acid resisting paint or varnish.		To be clearly mentioned	
c.	Detail of the paint system		To be provided	
d.	Corrosion protection method		To be provided	
10.2	**Primary bushings**			
a.	Conform to the requirement of EN 50180 type A bushings: plug-in pin contact with a current rating of 250 Amperes		Mandatory	
b.	Located on the top cover		Yes	
c.	Rated maximum voltage	kV	24	
d.	Power frequency withstand voltage (rms)	kV	50	
e.	Rated impulse withstand voltage (1.2/50µs).	kV	125	
f.	Plug in bushing are protected by a UV resistant plastic cover for storage and transportation		Yes	
10.3	**Secondary bushings**			
	Type of bushing		Porcelain Busbar	☐ ☐
1.	***Porcelain bushings*** -Porcelain bushings are aligned on the tank cover -Tested according IEC 60173 -Brown color -Manufacturer and year indelible marking		Yes	

	-Threaded parts and screws of metric sizes -Terminals suitable to received compression 240 mm² copper lugs with a hole of 13 mm diameter for insulated conductor. Pads are capable to receive the nb. and type of cable mentioned in § 10.2.4.2 M12x60 copper or stainless-steel bolts provided + one nut, two flat washers and one lock washer (or self-lock nut).			
a.	Drawing of pads		To be provided at tender stage	
b	Rated maximum voltage (Um)		1 kV	
c	Withstand voltage (50 Hz, 1 mn)		3 kV	
2.	***Busbar bushings***			
	Busbar bushings are designed and tested according EN 50387.		Yes	
	Busbar bushings aligned on the tank cover		Yes	
	Busbar bushings allow outdoor storage with temperature from 15°C to 50°C and under heavy rain.		Yes	
	Bar made of hot tinned (8µm) pure copper		Yes	
	Drilling according NEMA or EN 50387 or EDF HN 52S62		Yes	
	Bar are capable to receive compression 240 mm² copper lugs insulated conductor with a hole of 13 mm diameter.	Nb	Yes	
	Bar are capable to receive the Nb. And type of cable mentioned in § 10.2.4.2	Nb	Yes	
	M12x60 copper or stainless-steel bolts provided + one nut, two flat washers and one lock washer (or self-lock nut).		Yes	
a.	Drawing of busbar		To be provided at tender stage	
b	Rated maximum voltage	kV	1	
c	Withstand voltage (50 Hz, 1 mn)	kV	3	
d	OPTION : LV insulated bushing and connection protection box IP 2X (except rear side)		☐	
10.4	***Terminal permanent marking:***			
a.	Primary : A, B, C		Yes	
b.	Secondary : a, b, c and n		Yes	

10.5	**Label and rating plates** markings and instructions are clear and indelible and both in English and Khmer language Rating plate are embossed or engraved on weather proof rating plate with the following: • Type of transformer, • Specification to which standard it was manufactured, • Manufacturer's name, • Serial number, • Year of manufacturer, • Number of phases, • Rated capacity, • Rated frequency, • Rated voltages, • Rated currents, • Vector group, • Percentage impedance voltage at rated current, • Type of cooling, • Continuous ambient temperature at which ratings apply, • Top oil temperature rises at rated load, • Total weight, • Volume of oil, • Weight of core and windings, • Table of primary voltages at the 5 tapping positions, • Connection diagram. • Property of ELECTRICITE DU CAMBODGE and EDC logo • កម្មសិទ្ធិអគ្គិសនីកម្ពុជា		Yes Yes	
a.	plate or paint marking mentioning kVA rating in numerals 70 mm height on the tank and below the MV bushing.		Yes	
10.6 a.	**Oil** New, unused, clean, standard mineral oil in compliance with IEC 60296 and free from all traces of polychlorinated biphenyl (PCB) compounds.		Yes	

b.	Oil dielectric strength (IEC 60156) before transformer filling	kV	70	
10.7	**Transformer dimensions**			To be specified
a.	100 kVA	mm	H x L x W (1172×949×707)	
b.	160 kVA	mm	H x L x W (1224×1135×757)	
c.	200 kVA	mm	H x L x W (1315×1097×763)	
d.	250 kVA	mm	H x L x W (1285×1180×812)	
e.	315 kVA	mm	H x L x W (1360×1363×923)	
f.	400 kVA	mm	H x L x W (1440×1445×970)	
g.	500 kVA	mm	H x L x W (1500×1395×958)	
h.	630 kVA	mm	H x L x W (1580×1535×990)	
i.	800 kVA	mm	H x L x W	
j.	1000 kVA	mm	H x L x W	
k.	1250 kVA	mm	H x L x W	
l.	1600 kVA	mm	H x L x W	
m.	2000 kVA	mm	H x L x W	
n.	2500 kVA	mm	H x L x W	
o.	3000 kVA	mm	H x L x W	
10.8	**Transformer weight**			
a.	100 KVA	kg	to be specified	
b.	160 kVA	kg	to be specified	
c.	200 kVA	kg	to be specified	
d.	260 kVA	kg	to be specified	
e.	315 kVA	kg	to be specified	
f.	400 kVA	kg	to be specified	
g.	500 kVA	kg	to be specified	
h.	630 kVA	kg	to be specified	

i.	800 kVA	kg	to be specified	
j.	1000 kVA	kg	to be specified	
k.	1250 kVA	kg	to be specified	
l.	1600 kVA	kg	to be specified	
m.	2000 kVA	kg	to be specified	
n.	2500 kVA	kg	to be specified	
o.	3000 kVA	kg	to be specified	
11	Typical drawings of transformers including drawing of bushing shall be submitted.		To be provided at tender stage	
12	Month/ year of manufacture shall not be longer than one year on delivery at EDC's warehouse.		Yes	
13	Delivered suitably protected for transport and storage on a strong non-returnable wooden case pallet.		Yes	

Supplier's offer column must be properly filled with the right figures. "Compliant, Yes, ", V, etc..." are not accepted.

Deviation from the technical specification:

The bidder shall list point after point and explain here in after all deviation from the requested technical specification.

1/

2/

3/

x/

Full technical information shall be supplied within the bid.

Bidder signature:

15 ANNEX

Operating and Maintenance Costs

Since the operating costs of the transformers being procured form a major part of the life cycle cost, these costs will be evaluated based on prices and maximum guaranteed losses furnished by the Bidder in the relevant Schedule of Technical Particulars of the detailed technical specifications. The evaluation will be applied to the quantity of transformers given in Price Schedule.

The distribution transformers will be evaluated as the sum of the capital cost (adjusted for deviations as necessary) plus the capitalized value of the losses, as guaranteed in the Technical data sheet using the following formula:

G (USD) = A x load loss (kW) + B x no-load loss (kW)

Where: G is the capitalized value of the guaranteed losses, in accordance with the bidder offered technical data sheets.

A is capitalized cost of one kW of load loss and B is the capitalized cost of one kW of no-load loss.

Values of A and B are given in the bidding documents

There will be no credit for losses less than the guarantee. If transformers exceed the maximum losses requested values, the offer shall be rejected for non-responsiveness.