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TECHNICAL SPECIFICATION

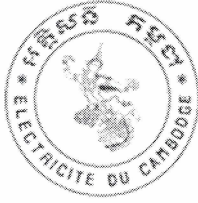
EDC-DTS-MV001

Pole Mounted Three-Phase and Two-Phase Outdoor Distribution Transformers


August 2019

Version 2.0





ELECTRICITE DU CAMBODGE

Version	Date	Technical Specification Name	Authorized by: (name and signature)
1.0	February, 2017	Pole Mounted Three-Phase and Two-Phase Outdoor Distribution Transformers	
2.0	August, 2019	Pole Mounted Three-Phase and Two-Phase Outdoor Distribution Transformers	 Dr. PRAING CHULASA



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Version	Drafted/reviewed by	Verified by	Approved by	Date
Draft 1				
DRAFT 2	AD			
FINAL	AD			
Appro	AD/EDC			
V 2.0				
Draft 1	AD/EDC			August 2018
FINAL	AD/EDC			August 2019

Version 2.0: Main modifications from version 1.0 (February 2017) are below:

- All transformer of hermetically sealed type
- Modification of thermometer range and max/min ambient temperatures
- Open to powder and other kind of paint (epoxy or acrylic) but salt spray test or equivalent to be supplied
- LV bushing location for 2-phase transformers
- LV Aluminum ABC 2×150 mm² for 200 and 250 kVA
- Rated impulse withstands voltage test for LV bushing not required
- Loses IEC tolerances are now included in maximum loses values
- Correction of minor typing mistakes and sentences wording.



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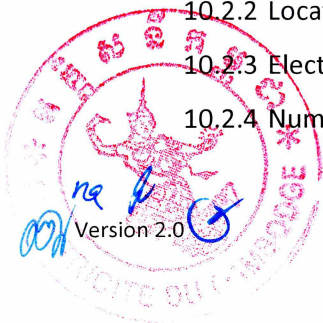
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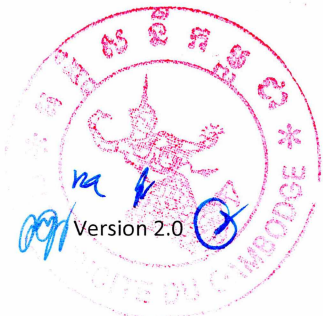
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15 ANNEX 70

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Pole Mounted Three-Phase and Two-Phase Outdoor Distribution Transformers

1 Scope

This specification covers the design, manufacturing, testing, supply, delivery and performance requirements of 2-phase and 3-phase, oil immersed, hermetically sealed outdoor pole mounted type distribution transformers for 22 kV and 35 kV levels to be used on the Power Distribution networks of EDC with a life expectancy of at least 25 years without any maintenance.

2 Standards

IEC : International Electrotechnical Commission

IEC 60071 : Insulation co-ordination

IEC 60076-SER : Power transformers - all parts

IEC 60137 : Insulated bushings for alternating voltages above 1 000 V

IEC 60296 : Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear

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

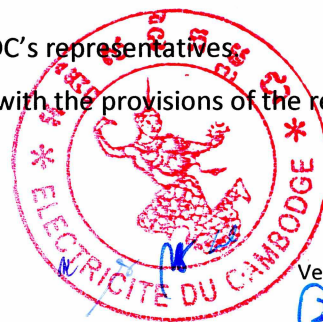
The definition of the relevant IEC standards applies to this technical specification.

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.

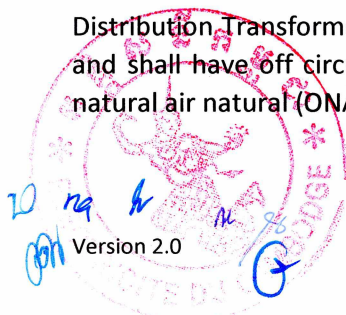
5 Quality Management

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

Distribution Transformers shall be 3-phase or 2-phase transformers, 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:

- 35 kV Transformers : Un: 35 kV, Um: 38 kV or 40.5 kV
- 35(22) kV Transformers (two primary voltages): Un: 35(22) kV, Um: 38/40.5(24) kV
- 22 kV Transformers : Un: 22 kV, Um: 24 kV

6.3 Secondary Voltage Rating

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

- Three-phase transformer : 0.23 /0.4 kV
- Two-phase transformer : 0.23 kV (2 poles)
: 0.23 /0.46 kV (3 poles)

7 Performance Characteristics

7.1 Ambient Conditions

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

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:

Transformer type	Primary Voltage	Secondary Voltage	Rated Capacity (kVA)
Two-phase Transformers	35 kV	230 V 2 LV bushings	25
	35 kV	230/460 V 3 LV bushings	50, 75, 100
	35 (22) kV	230 V 2 LV bushings	25
	35 (22) kV	230/460 V 3 LV bushings	50, 75, 100
	22 kV	230 V 2 LV bushings	25, 30
	22 kV	230/460 V 3 LV bushings	50
Three-phase Transformers	35 kV	230/400 V	50, 75, 100, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600
	35 (22) kV	230/400 V	50, 75, 100, 160, 200, 250, 315, 400, 500, 630
	22 kV	230/400 V	50, 75, 100, 160, 200, 250, 315, 400, 500, 630

All transformers shall be of outdoor type, designed for pole mounted and platform substations.

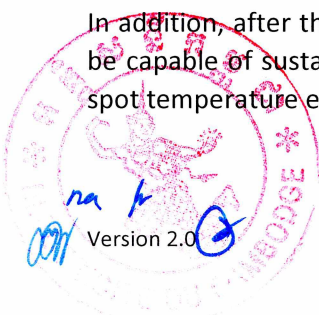
Each transformer shall be capable of supplying its rated capacity continuously for all tap positions with rated voltage on the secondary winding and continuous, steady load, a maximum temperature gradient of 21 °C and maximum winding hot spot of 98 °C. The transformers shall also be capable of delivering 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	
	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(s)

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

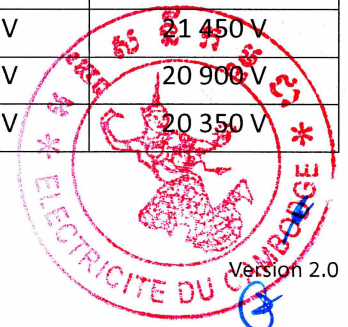
The lever(s) for operating the off-load tap changer and primary voltage changer (if any) shall be of externally operated type.

8.1.1 Voltage Ratio

Each transformer shall be fitted with 5 taps giving provision for off circuit changing of voltage ratio; Generally, the tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%. Nevertheless, **for transformer located in remote rural area, the tap setting shall be: +2.5 %, 0, -2.5%, -5 %, -7.5 %.**

The no load voltage ratios shall be:

Tap Number	Secondary Voltage 3-phase transformer	Secondary Voltage 2-phase transformer	Primary voltage for 35 kV winding	Primary voltage for 22 kV winding
Transformer for urban, peri-urban and rural areas				
1	230/400 V	230 V	36 750 V	23 100 V
2	230/400 V	230 V	35 875 V	22 550 V
3	230/400 V	230 V	35 000 V	22 000 V
4	230/400 V	230 V	34 125 V	21 450 V
5	230/400 V	230 V	33 250 V	20 900 V
Transformer for remote rural areas				
1	230/400 V	230 V	35 875 V	22 550 V
2	230/400 V	230 V	35 000 V	22 000 V
3	230/400 V	230 V	34 125 V	21 450 V
4	230/400 V	230 V	33 250 V	20 900 V
5	230/400 V	230 V	32 375 V	20 350 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.

For two primary voltage transformers, the changing between 2 primary voltage levels shall be carried out with an externally operated self-positioning tapping switch on the top of transformer without aid from another device. The handle shall give visual indication of the voltage position, and it shall be rotated in clockwise direction from a high tap to lower tap 35 kV to 22 kV.

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 pad-locking of the tapping switch handles in any desired position, with a 6 mm standard diameter padlock 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 be 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 distribution transformers shall be connected in accordance with IEC 60076 as follows:

Two-phase Transformers	
Capacity (kVA)	Vector Group
25 to 100	li-0

Three-phase Transformers	
Capacity (kVA)	Vector Group
50 to 1600	Dyn 11



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 (Um)	Power frequency withstand voltage (50Hz/1 mn)	Rated impulse withstand voltage (1.2/50 µs)
35 kV	38 or 40.5 kV	70 kV	170 kV
35(22) kV	38 or 40.5 kV	70 kV	170 kV
22 kV	24 kV	50 kV	125 kV
0.4 kV	1 kV	3 kV	----
0.23 kV	1 kV	3 kV	----

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

8.5 Impedance Voltage (Uk%)

8.5.1 Two-phase Transformers

8.5.1.1 35 kV and 35(22) kV transformers

The impedance on the principal tap (nominal voltage) of 35 kV transformers shall be:

25 kVA	2.2%
50 kVA	2.4%
75 kVA and 100kVA	3%

The impedance voltage shall be subject to the tolerance specified in IEC 60076.

8.5.1.2 22 kV transformers

The impedance on the principal tap (nominal voltage) of 22 kV transformers shall be:

up to 30 kVA	2%
50 kVA	2.2%

The impedance voltage shall be subject to the tolerance specified in IEC 60076.

8.5.2 Three-phase transformers

8.5.2.1 35 kV Transformers

The impedance on the principal tap (nominal voltage) shall be:



Impedance Voltage (Uk%)	Transformer capacity (kVA)
4%	50, 75
4.5%	100, 160, 200, 250, 315
5%	400, 500, 630, 800, 1000,
6%	1250, 1600

The impedance voltage shall be subject to the tolerance specified in IEC 60076.

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

8.5.2.2 22 kV Transformers

The impedance on the principal tap (nominal voltage) shall be 4%.

The impedance voltage shall be subject to the tolerance specified in IEC 60076.

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:

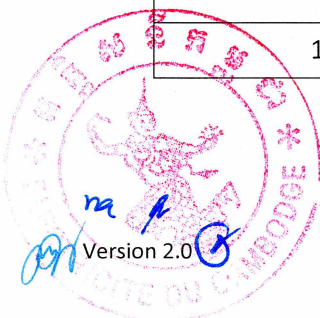
- a thermal withstanding to short circuit of 2 s.
- a mechanical withstanding to short circuit of 0.5 s with $I = I_{\text{rated}} \times 100 / Uk\%$,

Where Uk% is the impedance voltage.

8.7 Losses

According to Cambodia and EDC Standards for 35 kV and 22 kV distribution transformers, maximum values of losses accepted shall be as follows:

2-phase 35 kV and 35(22) kV Transformers		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 75 °C (W)
25	≤120	≤430
50	≤160	≤679
75	≤175	≤730
100	≤250	≤1260



2-phase 22 kV Transformers		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 75 °C (W)
25	≤115	≤430
30	≤120	≤500
50	≤150	≤670

3-phase 35 kV and 35(22) kV Transformers		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 75 °C (W)
50	≤170	≤950
75	≤230	≤1250
100	≤260	≤1550
160	≤370	≤2100
200	≤470	≤2500
250	≤520	≤2550
315	≤630	≤3500
400	≤750	≤4150
500	≤900	≤4950
630	≤1050	≤5850
800	≤1270	≤9900
1000	≤1300	≤12150
1250	≤1530	≤14850
1600	≤1850	≤17850

3-phase 22 kV Transformers		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 75 °C (W)
50	≤160	≤950
75	≤220	≤1250
100	≤250	≤1550
160	≤360	≤2100
200	≤450	≤2500
250	≤500	≤2950
315	≤600	≤3500
400	≤720	≤4150



3-phase 22 kV Transformers		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 75 °C (W)
500	≤860	≤4950
630	≤1010	≤5850

The losses shall be stated and guaranteed in the offer. The guaranteed losses including IEC tolerances 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.

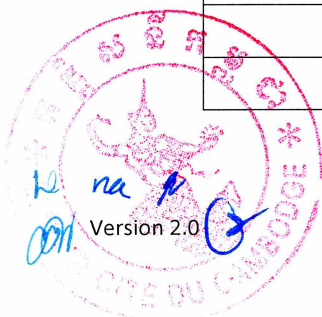
For all transformers, the limit of flux density at any point in the magnetic circuit shall be subject to the requirements for losses, harmonics and noise suppression.

8.10 Acoustic Sound Level

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

It shall not exceed:

Transformer Capacity (kVA)	Max Acoustic Sound level dB(A)	
2-phase transformers		
	35 kV and 35(22) kV	22 kV
25	45	45
30	45	45
50	46	46
75	47	47
100	48	48
3-phase transformers		
	35 kV and 35(22) kV	22 kV
50	47	47
75	48	48



100	49	49
160	52	52
200	53	53
250	55	55
315	56	56
400	58	58
500	59	59
630	60	60
800	61	61
1000	63	63
1250	64	64
1600	66	66

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.

Nevertheless, for two-phase transformers, as they are allowed to be of gas cushion oil preservation system, the cover can be welded to the tank for this type of transformers.

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.

All bolts used on transformers shall be made of stainless steel and be of metric size.

9.1.1 Special Fitting for Surge Arresters (option)

As option expressed in the tender documents, transformers shall be fitted with special cross arm for supporting surge arresters on the upper part of the transformer located on MV bushing transformer side.

9.2 Sealing

The transformer tank shall be sealed by means of:

- suitable gasket for Three phase and two-phase transformers



- welding for two-phase gas cushion type transformers only

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

9.3.1 Three-phase Transformers

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.

9.3.2 Two-phase Transformers

- Sealed, completely filled system in which the expansion of the oil is taken up by elastic movement of the permanently sealed, usually corrugated tank or;
- Sealed tank system with gas cushion, in which a volume of gas above the liquid surface in a stiff tank accommodates the liquid expansion under variable pressure.

9.4 Cooling

The tank shall be designed for natural cooling (ONAN) with a corrugated wall tank (radiator for 2-phase Sealed tank system with gas cushion) 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 (one for two-phase transformers). 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 bushings.

9.6 Under Frame

Three-phase Transformer shall be fitted with an under frame suitable for bolting the transformer to a pole mounted platform.

Two-phase transformers shall be fitted with a single hole fixing bracket and a steady bracket to enable the transformers to be mounted on a single pole. The upper fixing bracket must be located sufficiently near the top of the tank to ensure stable hanging.

9.7 Filling and Draining

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



9.8 Earthing

9.8.1 Three-phase Transformers

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.

Earthing symbol shall be provided near the earthing holes.

9.8.2 Two-phase Transformers

Similarly, to the three-phase transformers, the two-phase transformers shall be fitted with two of 10 mm diameter hole for connection of earth wires copper lug on each lower side of the transformer.

Earthing symbol shall be provided near the earthing holes.

9.9 Core 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

Three phase 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 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



The thermometer shall be suitably protected or self-protected against corrosion

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

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 preferably 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 provided the manufacturer prove a surface treatment lifespan that meet the lifespan of the transformer (25 years without maintenance) by providing salt spray test.

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 porcelain bushings. All bushings shall be so designed that there will be no excessive stressing of any parts due to temperature changes and adequate means shall be provided to accommodate conductor expansion.

10.1.2 Location

Primary bushings shall be located on the transformer cover.

10.1.3 Insulation Level

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

10.1.4 Creepage Distance

The creepage distances for the bushings and the insulators shall not be less than 25 mm/kV for the considered highest voltage:

Rated maximum voltage (Um)	Minimum Creepage distance
24 kV	600 mm
38 kV	950 mm

10.1.5 Construction

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 flexibility.

Clamps and similar details made of steel or malleable iron shall be galvanized.

Copper or copper alloy terminals shall be tinned to a thickness of minimum 50 μm . Copper alloys shall not be sensitive to cracking.

The bushings shall be so installed that they are easy to be checked and removed without removing the tank cover.

10.1.6 Terminals

External terminals shall comply with the requirements of High Voltage Terminals and shall be suitable to received bi-metallic aluminum/copper crimped lugs with a hole of 13 mm diameter.

Threaded parts and screws shall be of metric sizes.

10.1.7 Insulating Covers

Flexibles and UV and weather resistant terminal insulating covers shall be provided for wildlife protection. The insulation withstand of insulating cover shall not be less than 24 kV per 1 minute (power frequency voltage).

10.2 Secondary Bushings

10.2.1 General

Distribution transformer shall be supplied with porcelain bushings on LV side. Secondary bushings include porcelain insulator and copper terminal.

10.2.2 Location

The LV bushing shall be located as follow:



Transformer type	LV bushings location
Two-phase transformers: 25, 30, 50, 75 and 100 kVA	On the upper part of the transformer tank and on the opposite side of the pole fixing device for gas cushion oil preservation type transformers. On the top cover or left side or right side of the tank for integral oil filling transformers with corrugated tank
Three-phase transformers: 50, 75, 100, 160 kVA	On the tank cover or on the upper part of the right or left side of the transformer tank.
Three-phase transformers: 200, 250, 315, 400, 500, 630, 800, 1000, 1250 and 1600 kVA	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 Number of Two-phase Transformer LV Bushings

Transformer Capacity (kVA)	Number of LV bushing
25, 30	2 bushings for two wires LV network (230 V)
50, 75, 100	3 bushings for three wires LV network (2x230V)

10.2.5 Construction

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 flexibility.



10.2.6 Terminals

10.2.6.1 Two-phase transformers

External terminals shall be suitable to received bi-metallic pre-insulated aluminum/copper lugs for Aluminum ABC with a hole of 13 mm diameter.

Threaded parts and screws shall be of metric sizes.

10.2.6.2 Three-phase transformers

The LV terminals shall be:

Transformer capacity (kVA)	Type of terminals
50, 75, 100, 160	<ul style="list-style-type: none"> - External terminals shall be suitable to received one bi-metallic pre-insulated compression aluminum/copper lugs for Aluminum ABC with a hole of 13 mm diameter. - LV Aluminum ABC shall be of 150 mm² cross section. - Threaded parts and screws shall be of metric sizes and protected against corrosion.
200, 250, 315	<ul style="list-style-type: none"> - LV bushings shall be equipped with terminal pad connectors made of high conductivity copper/bronze and hot-tin dipped. The tin thickness shall not be less of 8 micron (µm). - Each pad shall be suitable to received two bi-metallic pre-insulated compression aluminum/copper lugs for Aluminum ABC with a hole of 13 mm diameter. - LV Aluminum ABC shall be of 150 mm² cross section - Threaded parts and screws shall be of metric sizes and protected against corrosion. - Each hole (if any) shall be fitted with one M12x60mm stainless steel or copper bolt including one nut, two flat washers and one lock washer.
400, 500, 630, 800, 1000, 1250, 1600	<ul style="list-style-type: none"> - LV bushings shall be equipped with terminal pad connectors (stud type connectors are preferable), of high conductivity copper/bronze and hot-tin dipped. The tin thickness shall not be less of 8 micron (µm). - 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 1x240 mm² cables fitted with compression lugs with a 13mm diameter hole and according the requirements here in after: <ul style="list-style-type: none"> 400 kVA : Two cables for each phase and one cable for neutral 500, 630 kVA : Three cables for each phase and two cables for neutral 800, 1000 kVA : Four cables for each phase and two cables for neutral 1250 kVA : Five cables for each phase and two cables for neutral 1600 kVA : Six cables for each phase and three 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. Connectors shall be provided with mounting hardware (bolts, nuts, washers and lock washers) of stainless steel.

10.2.7 Insulating Covers

Flexibles and UV weather resistant terminal insulating covers shall be provided for wildlife protection. The insulation withstand of insulating cover shall not be less than 24 kV per 1 minute (power frequency voltage).

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:

10.3.1 Three-phase Transformer:

- Primary voltage: A, B, C
- Secondary voltage: a, b, c and n

10.3.2 Two-phase Transformer:

- Primary voltage: A, B
- Secondary voltage:
 - a, b for 25 and 30 kVA transformers
 - a, n, b for 50, 75 and 100 kVA transformers

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 LV 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

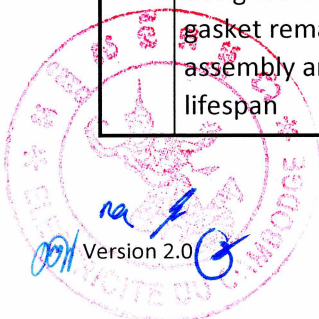
Transformers shall be delivered suitably protected for transport and storage on a strong enough non-returnable wooden case pallet.



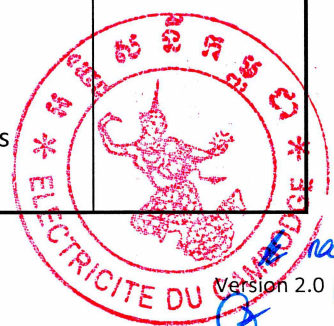
14 Technical Data Sheets

14.1 22 kV Two-Phase Pole Mounted Transformers

No.	Descriptions	Unit	Requirement	Supplier's Offer
	22 kV Two-phase pole mounted transformers		25 kVA <input type="checkbox"/> 30 kVA <input type="checkbox"/> 50 kVA <input type="checkbox"/>	
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				
1	Outdoor pole mounted installation and operation on MV distribution network with nominal voltage 12.7/22 kV, 50Hz with the life expectancy of at least 25 years.		Yes	
2	Oil-immersed transformers, self-cooled (ONAN), two winding and two-phase type.		Yes	
3	Ambient condition as per § 7.1		Yes	
4	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.	Bolt corrosion protection		To be specified	
c.	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	

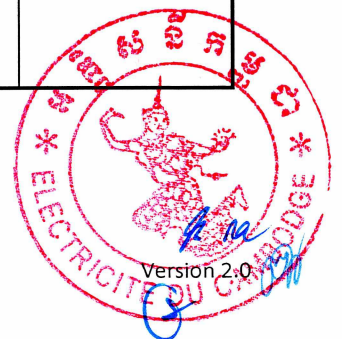


d.	The transformer tank is designed in such a manner that the completed transformer can be lifted and transported without permanent deformation or oil leakage.		Yes	
e.	The tank and cover are designed in such a manner to prevent external pockets in which water can lodge.		Yes	
f.	All pipes, fins or corrugation are externally welded to the tank wall.		Yes	
2.	Sealing			
a.	The transformer tank is sealed by means of suitable gasket or welding.		To be specified	
b.	The tank cover is removable for core and coils access.		To be specified	
c.	Transformer parts inside the tank are able to remove upward in one piece with the lift of the tank cover.		To be specified	
d.	All gaskets (if any) 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.	- Sealed, completely filled system in which the expansion of the oil is taken up by elastic movement of the permanently sealed, usually corrugated tank or ; - Sealed tank system with gas cushion, in which a volume of gas above the liquid surface in a stiff tank accommodates the liquid expansion under variable pressure.		Yes To be specified	
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 one closed lifting lugs located on the transformer cover. The minimum diameter of the hole shall be 25 mm. The lifting lug(s) shall be located such that there will be a minimum of 50 mm between the		Yes	



	lifting chain and the nearest part of the LV bushings.			
d.	Transformer is fitted with an under frame suitable for supporting the transformer on a flat surface.		Yes	
e.	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.	Core 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 be designed to meet 1.55 to 1.65 tesla.	Tesla	To be specified	
e.	The windings are designed and manufactured to resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
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		li-0	
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 (1.2/50 μs)	kV	125	
e.	Frequency	Hz	50	

4.2	Secondary			
a.	Service voltage			
	-25 and 30 kVA	kV	0.230	
	-50 kVA	kV	0.230/0.460	
b.	Rated Maximum Voltage (Um)	kV	1	
c.	Power frequency withstand voltage (1 mn)	kV	3	
5.	Impedance voltage on the nominal voltage tap:			
a.	25 and 30 kVA		2%	
b.	50 kVA		2.2%	
c.	The impedance voltage is subject to the tolerance specified in IEC 60076.		Yes	
6.	Short-circuit performance			
a.	Sustaining a 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 2s.		To be specified	
c.	Mechanical withstanding to short circuit of 0.5 sec with $I = I_{\text{rated}} \times 100 / U_k\%$,		To be specified	
7.	Tap changer			
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.	* For urban area , the tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%, * For remote rural area , the tap setting shall be: +2.5%, 0%, -2.5%, -5%, -7.5%		<input type="checkbox"/> <input type="checkbox"/>	
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		To be described	
f.	Provision is made for locking of the tapping switch handles in any desired position, with a 6 mm standard diameter hasp lock		Yes	
8.	Losses			To be specified
a.	25 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 115 ≤ 430 	
b.	30 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 120 ≤ 500 	
c.	50 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 150 ≤ 670 	
9.	Acoustic sound Level			To be specified
a.	25 kVA	dB(A)	≤ 45	
b.	30 kVA	dB(A)	≤ 45	
c.	50 kVA	dB(A)	≤ 46	
10.	Accessories			
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.	All other transformer necessary accessories are supplied with the transformer		Yes	
10.1	Surface treatment			
a.	Transformers and smaller parts such as brackets, etc. are powder painting with Dark Grey color-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.	-Porcelain bushings conform to the requirement of IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression -Aluminum/copper bimetallic lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
b.	Located on the top cover		Yes	
c.	Rated maximum voltage (Um)	kV	to be specified	
d.	Minimum creepage distance	mm	600	
e.	Power frequency withstand voltage (rms)	kV	to be specified	
f.	Rated impulse withstand voltage (1.2/50 μ s).	kV	to be specified	
10.3	Secondary bushings			
a.	-Porcelain bushings are located on upper side of the tank cover -Tested according IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression aluminum/copper lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
10.4	Number of LV bushing			
a.	25 and 30 kVA		2	
b.	50 kVA		3	
c.	Rated voltage		1 kV	
d.	Withstand voltage (50 Hz, 1 mn)		3 kV	
10.5	Terminal permanent marking: Primary: A, B Secondary: - a, b for 25 and 30 kVA - a, n, b for 50 kVA		Yes Yes Yes	To be specified



10.6	Label and rating plates			To be specified
a.	<p>-markings and instructions are clear and indelible and both in English and Khmer language</p> <p>-Rating plate is embossed or engraved on weather proof rating plate with the following:</p> <ul style="list-style-type: none"> • 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 		Yes	
b.	plate or paint marking mentioning kVA rating in numerals 70 mm height on the tank and below the MV bushing.		Yes	
10.7	Oil			



a.	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	
10.8	Transformer dimensions			To be specified
a.	25 kVA	mm	H x L x W	
b.	30 kVA	mm	H x L x W	
c.	50 kVA	mm	H x L x W	
10.9	Transformer weight			
a.	25 kVA	kg	To be specified	
b.	30 kVA	kg	To be specified	
c.	50 kVA	kg	To be specified	
11	Typical drawings of transformers including drawing of bushings.		To be submitted 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.				
<p>Deviation from the technical specification:</p> <p>The bidder shall list point after point and explain here in after all deviation from the requested technical specification.</p> <p>1/ 2/ 3/ x/</p> <p style="text-align: center;">Full technical information shall be supplied within the bid.</p> <p style="text-align: center;">Bidder signature:</p>				



14.2 35 kV and 35(22) kV Two-phase Pole Mounted Transformer

No.	Description	Unit	Requirement	Supplier's Offer
	<i>35 kV and 35(22) kV two-phase transformer</i>		25 kVA <input type="checkbox"/> 50 kVA <input type="checkbox"/> 75 kVA <input type="checkbox"/> 100 kVA <input type="checkbox"/>	
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.	Outdoor pole mounted installation and operation on MV distribution network with nominal voltage 35 kV, or 35 (22) kV, 50Hz with the life expectancy of at least 25 years.		Yes	
b.	Oil-immersed transformers, self-cooled (ONAN), two windings and two-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 or welded.		To be specified	
b.	Bolt corrosion protection		To be specified	
c.	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	
d.	The transformer tank is designed in such a manner that the completed transformer can		Yes	

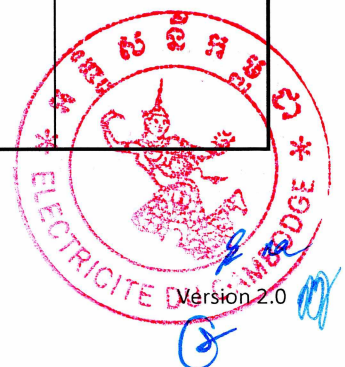
	be lifted and transported without permanent deformation or oil leakage.			
e.	The tank and cover are designed in such a manner to prevent external pockets in which water can lodge.		Yes	
f.	All pipes, fins or corrugation are externally welded to the tank wall.		Yes	
2.	Sealing			
a.	The transformer tank is sealed by means of suitable gasket or welding.		To be specified	
b.	The tank cover is removable for core and coils access.		To be specified	
c.	Transformer parts inside the tank are able to remove upward in one piece with the lift of the tank cover.		To be specified	
d.	All gaskets (if any) 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.	Sealed, completely filled system in which the expansion of the oil is taken up by elastic movement of the permanently sealed, usually corrugated tank or; Sealed tank system with gas cushion, in which a volume of gas above the liquid surface in a stiff tank accommodates the liquid expansion under variable pressure.		To be specified	
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 one closed lifting lugs located on the transformer cover. The minimum diameter of the hole shall be 25 mm. The lifting lug(s) 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	

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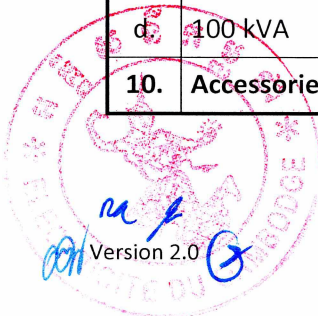


d.	Transformers are fitted with an under frame suitable for supporting the transformer on a flat surface.		Yes	
e.	Filling stub inner and drain plug diameter		≥ 25 mm	
4.	Cores and coils			
a.	The core and coil assembly have the core and coils rigidly connected to the tank and shall not shift in any 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.	Core 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 damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
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		li-0	
4.1	Primary for 35 kV transformers			
a.	service voltage (Un)	kV	35	
b.	Rated maximum voltage (Um)	kV	38 or 40.5	
c.	Power frequency withstand voltage (1 mn)	kV	70	
d.	Rated impulse voltage (1.2/50μs)	kV	170	
4.2	Primary for 35(22) kV transformers			
a.	Service voltage (Un)	kV	35 (22)	

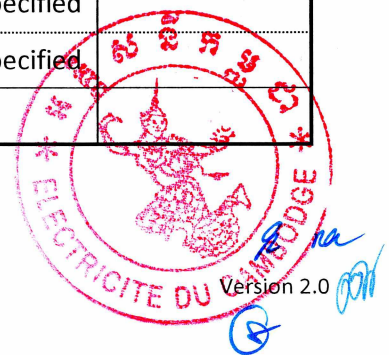
b.	Rated maximum voltage (Um)	kV	38 or 40.5	
c.	Power frequency withstand voltage (1 mn)	kV	70	
d.	Rated impulse voltage (1.2/50µs)	kV	170	
e.	Frequency	Hz	50	
4.3	Secondary			
a.	Service voltage (Un)			
	- 25 kVA	kV	0.230	
	- 50, 75 and 100 kVA	kV	0.230/0.460	
b.	Rated Maximum Voltage (Um)	kV	1	
c.	Power frequency withstand voltage (1 mn)	kV	3	
5.	Impedance voltage on the nominal voltage tap:			
a.	25 kVA		2.2%	
b.	50 kVA		2.4%	
c.	75 and 100 kVA		3%	
d.	The impedance voltage is subject to the tolerance specified in IEC 60076.		Yes	
6.	Short circuit performance			
a.	Sustaining a 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 sec with $I = I_{\text{rated}} \times 100 / U_k\%$,		To be specified	
7.	Tap changer			
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.	* For urban area , the tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%, * For remote rural area , the tap setting shall be: +2.5%, 0%, -2.5%, -5%, -7.5%		<input type="checkbox"/> <input type="checkbox"/>	



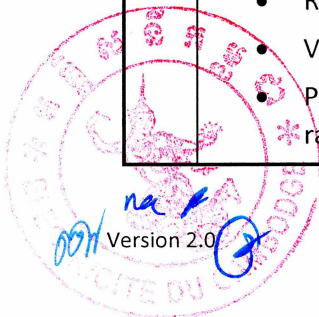
d.	The handle gives visual indication of the tapping position, and it shall be rotated in clockwise direction from a high tap to lower tap "1" to "5". Switch position No.1 shall correspond to the primary voltage that gives the highest voltage ratio.		Yes	
e.	For 35 (22) kV transformers, the high voltage winding is provided with 2 positions off-load voltage changer for primary voltage changing. The lever for operating the voltage changer is of externally operated type and shall be made by non-corrosive metal.		Yes Yes	
f.	The tap or voltage changer position is indelibly marked by embossing or engraving and with weather proof paint		To be specified	
g.	Provision is made for locking of the tapping switch handles in any desired position, with a 6 mm standard diameter hasp lock		Yes	
8.	Losses			To be specified
a.	25 kVA • No load • Load (75°C)	W	• ≤ 120 • ≤ 430	
b.	50 kVA • No load • Load (75°C)	W	• ≤ 160 • ≤ 679	
c.	75 kVA • No load • Load (75°C)	W	• ≤ 175 • ≤ 730	
d.	100 kVA • No load • Load (75°C)	W	• ≤ 250 • ≤ 1260	
9.	Acoustic sound Level			To be specified
a.	25 kVA	dB(A)	≤ 45	
b.	50 kVA	dB(A)	≤ 46	
c.	75 kVA	dB(A)	≤ 47	
d.	100 kVA	dB(A)	≤ 48	
10.	Accessories			



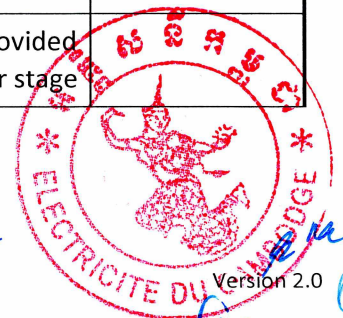
a.	The transformers are equipped with an overpressure relief device. The overpressure relief device is covered with a suitable "cover" to protect persons in the vicinity of the transformer against the spurting of hot oil in the event of an internal fault of the transformer		Yes	
b.	All other transformer necessary accessories are supplied with the transformer		Yes	
10.1	Surface treatment			
a.	Transformers and smaller parts such as brackets, etc. are powder painting with Dark Grey color-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 specified	
e.	Paint salt spray test or equivalent proving paint lifespan		To be provided	
10.2	Primary bushings			
a.	-Porcelain bushings conform to the requirement of IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression -Aluminum/copper bimetallic lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
b.	Located on the top cover		Yes	
c.	Rated maximum voltage	kV	to be specified	
d.	Minimum creepage distance	mm	950	
e.	Power frequency withstand voltage (rms)	kV	to be specified	
f.	Rated impulse withstand voltage (1.2/50 μ s).	kV	to be specified	
10.3	Secondary bushings			



a.	-Porcelain bushings are located on upper side of the tank -Tested according IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression aluminum/copper lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
10.4	Number of LV bushing			
	- 25 kVA		2	
	- 50, 75 and 100 kVA		3	
a.	Rated maximum voltage (Um)	kV	1	
b.	Withstand voltage (50 Hz, 1 mn)	kV	3	
10.5	Terminal permanent marking			To be specified
a.	Primary: A, B		Yes	
b.	Secondary: (2 bushings) : a, b (3 bushings) : a, n, b		Yes Yes	
10.6	Label and rating plates -Markings and instructions are clear and indelible and both in English and Khmer language -Rating plate is embossed or engraved on weather proof rating plate with the following: <ul style="list-style-type: none"> • 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, 		Yes Yes	To be specified



	<ul style="list-style-type: none"> 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 			
b.	plate or paint marking mentioning kVA rating in numerals 70 mm height on the tank and below the MV bushing.		Yes	
10.7	Oil			
a.	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	
10.8	Transformer dimensions			
a.	25 kVA	mm	H x L x W	
b.	50 kVA	mm	H x L x W	
c.	75 kVA	mm	H x L x W	
d.	100 kVA	mm	H x L x W	
10.9	Transformer weight			
a.	25 KVA	kg	To be specified	
b.	50 kVA	kg	To be specified	
c.	75 kVA	kg	To be specified	
d.	100 kVA	kg	To be specified	
11	Typical drawings of transformers including drawing of bushings.		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.				
<p style="text-align: center;">Deviation from the technical specification:</p> <p>The bidder shall list point after point and explain here in after all deviation from the requested technical specification.</p> <p>1/ 2/ 3/ x/</p> <p style="text-align: center;">Full technical information shall be supplied within the bid.</p> <p style="text-align: center;">Bidder signature:</p>				

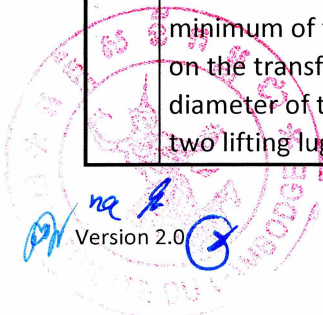


14.3 22 kV Three-Phase Pole Mounted Transformers

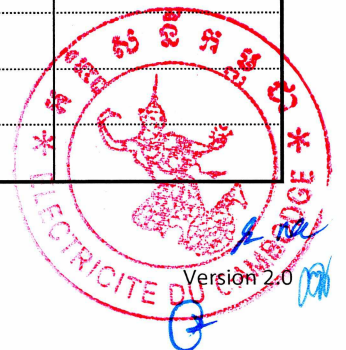
No.	Description	Unit	Requirement	Supplier's Offer
	22 kV Three-phase pole mounted transformers		50 kVA <input type="checkbox"/> 75 kVA <input type="checkbox"/> 100 kVA <input type="checkbox"/> 160 kVA <input type="checkbox"/> 200 kVA <input type="checkbox"/> 250 kVA <input type="checkbox"/> 315 kVA <input type="checkbox"/> 400 kVA <input type="checkbox"/> 500 kVA <input type="checkbox"/> 630 kVA <input type="checkbox"/>	
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				
1	Outdoor pole mounted installation and operation on MV distribution network with nominal voltage 12.7/22 kV, 50Hz with the life expectancy of at least 25 years.		Yes	
2	Oil-immersed transformers, self-cooled (ONAN), two winding, and three phase type.		Yes	
3	Ambient condition as per § 7.1		Yes	
4	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			



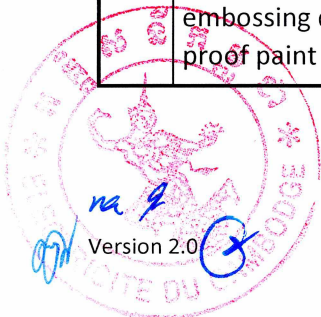
	designed in such manner the tank/cover gasket remains in correct position during assembly and all along the transformer lifespan		Yes	
c.	The transformer tank is designed in such a manner that the completed transformer can be lifted and transported without permanent deformation or oil leakage.		Yes	
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.	Transformers 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		Yes	



	there will be a minimum of 50 mm between the lifting chain and the nearest part of the LV bushings.			
d.	Three-phase Transformer is fitted with an under frame suitable for supporting the transformer on a flat surface.		Yes	
e.	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 be designed to meet 1.55 to 1.65 tesla.	Tesla	To be specified	
e.	The windings are designed and manufactured to resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
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		Dyn11 (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	



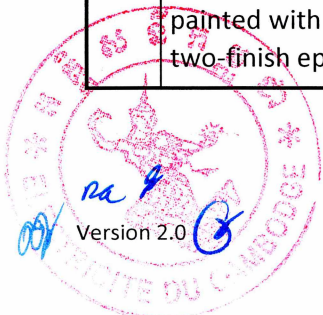
d.	Rated impulse voltage (1.2/50 μ s)	kV	125	
e.	Frequency	Hz	50	
4.2	Secondary			
a.	Service voltage (Un)	kV	0.23/0.40	
b.	Rated Maximum Voltage (Um)	kV	1	
c.	Power frequency withstand voltage (1 mn)	kV	3	
5.	Impedance voltage on the nominal voltage principal tap		4%	
a.	The impedance voltage is subject to the tolerance specified in IEC 60076.		Yes	
6.	Short circuit performance			
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 sec with $I = I \text{ rated} \times 100 / Uk\%$,		To be specified	
7.	Tap changer			
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.	* For urban area , the tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%, * For remote rural area , the tap setting shall be: +2.5%, 0%, -2.5%, -5%, -7.5%		<input type="checkbox"/> <input type="checkbox"/>	
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		To be specified	



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			To be specified
a.	50 kVA • No load • Load (75°C)	W	• ≤ 160 • ≤ 950	
b.	75 kVA • No load • Load (75°C)	W	• ≤ 220 • ≤ 1250	
c.	100 kVA • No load • Load (75°C)	W	• ≤ 250 • ≤ 1550	
d.	160 kVA • No load • Load (75°C)	W	• ≤ 360 • ≤ 2100	
e.	200 kVA • No load • Load (75°C)	W	• ≤ 450 • ≤ 2500	
f.	250 kVA • No load • Load (75°C)	W	• ≤ 500 • ≤ 2950	
g.	315 kVA • No load • Load (75°C)	W	• ≤ 600 • ≤ 3500	
h.	400 kVA • No load • Load (75°C)	W	• ≤ 720 • ≤ 4150	
i.	500 kVA • No load • Load (75°C)	W	• ≤ 860 • ≤ 4950	
j.	630 kVA • No load • Load (75°C)	W	• ≤ 1010 • ≤ 5850	
9.	Acoustic sound Level			To be specified
a.	50 kVA	dB(A)	≤ 47	
b.	75 kVA	dB(A)	≤ 48	
c.	100 kVA	dB(A)	≤ 49	
d.	160 kVA	dB(A)	≤ 52	

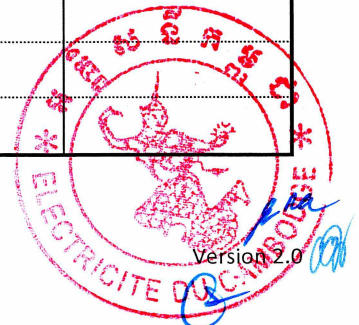


e.	200 kVA	dB(A)	≤ 53	
f.	250 kVA	dB(A)	≤ 55	
g.	315 kVA	dB(A)	≤ 56	
h.	400 kVA	dB(A)	≤ 58	
i.	500 kVA	dB(A)	≤ 59	
j.	630 kVA	dB(A)	≤ 60	
10.	Accessories			
a.	The transformers are equipped with an overpressure relief device. The overpressure relief device is covered with a suitable "cover" to protect 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 transformers are 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 technical characteristics -Mounting -Range (°C) -Accuracy -Ambient operating temperature (°C) -Protective index (IEC 60529) -Suitably protected against corrosion		Top mount 20 to 120 ± 2% 0 to 60 IP 55 Yes	
e.	All other transformer necessary accessories are supplied with the transformer		Yes	
10.1	Surface treatment			
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	
e.	Paint salt spray test or equivalent test proving paint lifespan		To be provided	
10.2 Primary bushings				
a.	-Porcelain bushings conform to the requirement of IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression -Aluminum/copper bimetallic lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
b.	Located on the top cover		Yes	
c.	Rated maximum voltage (Um)	kV	24	
d.	Minimum creepage distance	mm	600	
e.	Power frequency withstand voltage (rms)	kV	50	
f.	Rated impulse withstand voltage (1.2/50µs).	kV	125	
10.3 Secondary bushings				
1.	50, 75, 100 and 160 kVA transformers: -Porcelain bushings located on the tank top cover or on the upper part of the right or left side of the transformer tank Tested according IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression 150 mm ² aluminum/copper lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
a.	Rated voltage		1 kV	
b.	Withstand voltage (50 Hz, 1 mn)		3 kV	
2.	200, 250 and 315 kVA transformers			

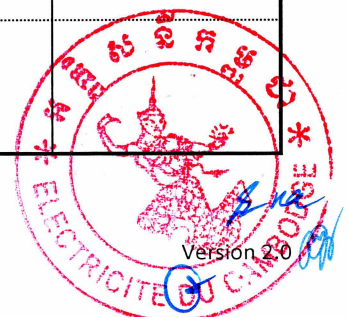
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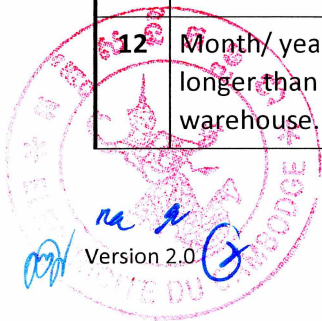
	<ul style="list-style-type: none"> - Porcelain bushings are located on the tank top cover - LV bushings are equipped with terminal pad connectors made of high conductivity copper/bronze and hot-tin dipped. The tin thickness shall not be less of 8 micron (μm). - Bushings are aligned on the tank cover - Each pad is suitable to received two bi-metallic pre-insulated compression aluminum/copper lugs for 150 mm² Aluminum ABC with a hole of 13 mm diameter. - Threaded parts and screws are of metric sizes and protected against corrosion. - Each hole is fitted with one M12x60mm stainless steel or copper bolt including one nut, two flat washers and one lock washer. 		Yes	
			Yes	
			Yes	
			Yes	
			Yes	
a.	Rated voltage		1 kV	
b.	Withstand voltage (50 Hz, 1 mn)		3 kV	
3.	<p>400 kVA and more transformers:</p> <p>Porcelain bushings located on the tank top cover</p> <ul style="list-style-type: none"> - LV bushings shall be equipped with terminal pad connectors of high conductivity copper/bronze and hot-tin dipped (8 μm). - Pad drilling according NEMA or EN 50387 or EDF HN 52S62 or any equivalent standard - Bushings aligned on the tank cover <p>It is possible to connect copper insulated 1x240mm² cables fitted with compression lugs with a 13mm diameter hole and according the requirements here in after:</p> <ul style="list-style-type: none"> • 400 kVA : Two cables for each phase and one cable for neutral • 500, 630 kVA : Three cables for each phase and two cables for neutral <p>M12x60 copper or stainless-steel bolts provided + one nut, two flat washers and one lock washer.</p>		Yes	
			Yes	
			Yes	
			To be specified	
			Yes	
			Yes	
			Yes	
			Yes	



a.	Rated maximum voltage (Um)	kV	1	
b.	Withstand voltage (50 Hz, 1 mn)	kV	3	
10.4	Terminal permanent marking: Primary: A, B, C Secondary: a, b, c and n		Yes Yes	
10.5	Label and rating plates -Markings and instructions are clear and indelible and both in English and Khmer language -Rating plate is embossed or engraved on weather proof rating plate with the following: <ul style="list-style-type: none"> • 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 		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	Oil			
a.	New, unused, clean, standard mineral oil in compliance with IEC 60296 and free from all traces of polychlorinated biphenyl (PCB) compounds.		To be specified	
b.	Oil dielectric strength (IEC 60156) before transformer filling	kV	70	
10.7	Transformer dimensions			To be specified
a.	50 kVA	mm	H × L × W	
b.	75 kVA	mm	H × L × W	
c.	100 kVA	mm	H × L × W	
d.	160 kVA	mm	H × L × W	
e.	200 kVA	mm	H × L × W	
f.	250 kVA	mm	H × L × W	
g.	315 kVA	mm	H × L × W	
h.	400 kVA	mm	H × L × W	
i.	500 kVA	mm	H × L × W	
j.	630 kVA	mm	H × L × W	
10.8	Transformer weight			
a.	50 kVA	kg	To be specified	
b.	75 kVA	kg	To be specified	
c.	100 kVA	kg	To be specified	
d.	160 kVA	kg	To be specified	
e.	200 kVA	kg	To be specified	
f.	260 kVA	kg	To be specified	
g.	315 kVA	kg	To be specified	
h.	400 kVA	kg	To be specified	
i.	500 kVA	kg	To be specified	
j.	630 kVA	kg	To be specified	
11	Typical drawings of transformers including drawing of bushings.		To be submitted at tender stage	
12	Month/ year of manufacture shall not be longer than one year on delivery at EDC's warehouse.		Yes	



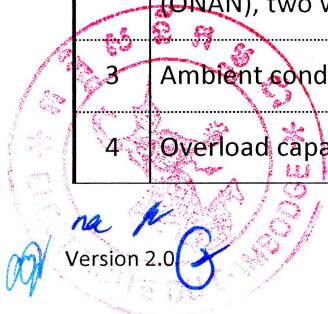
13	Delivered suitably protected for transport and storage on a strong non-returnable wooden case pallet.		Yes	
Supplier's offer column must be properly filled with the right figures. "Compliant, Yes, ", V , etc..." are not accepted.				
<p style="text-align: center;">Deviation from the technical specification:</p> <p>The bidder shall list point after point and explain here in after all deviation from the requested technical specification.</p> <p>1/ 2/ 3/ x/</p> <p style="text-align: center;">Full technical information shall be supplied within the bid.</p> <p style="text-align: center;">Bidder signature:</p>				

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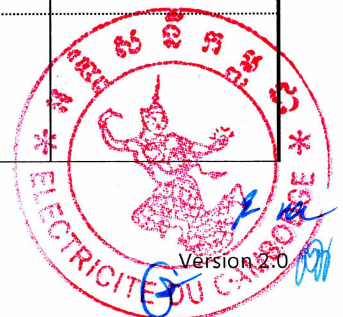


14.4 35 kV and 35(22) kV Three-Phase Pole Mounted Transformers

No.	Description	Unit	Requirement	Supplier's Offer
	35 kV and 35(22) kV three-phase pole mounted transformers		50 kVA <input type="checkbox"/> 75 kVA <input type="checkbox"/> 100 kVA <input type="checkbox"/> 160 kVA <input type="checkbox"/> 200 kVA <input type="checkbox"/> 250 kVA <input type="checkbox"/> 315 kVA <input type="checkbox"/> 400 kVA <input type="checkbox"/> 500 kVA <input type="checkbox"/> 630 kVA <input type="checkbox"/> 800 kVA <input type="checkbox"/> 1000 kVA <input type="checkbox"/> 1250 kVA <input type="checkbox"/> 1600 kVA <input type="checkbox"/>	
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				
1	Outdoor pole mounted installation and operation on MV distribution network with nominal voltage of 35 kV or 35(22) kV, 50Hz with the life expectancy of at least 25 years.		Yes	
2	Oil-immersed transformers, self-cooled (ONAN), two winding, and three phase type.		Yes	
3	Ambient condition as per § 7.1		Yes	
4	Overload capacity		To be specified	

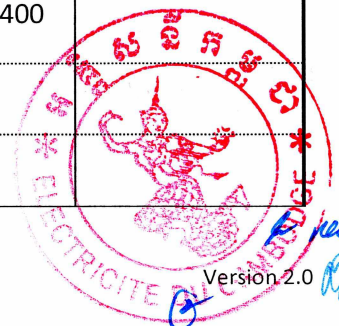


II. Construction and physical characteristics				
1.	Tank			
a.	Tank and cover are constructed of welded steel sheets. The joints between tank and cover provided with suitable flanges bolted together with gaskets.		Yes	
b.	The cover is formed of steel sheet and electrically bonded to the tank. It is 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 of all capacities 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. 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. Core 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	

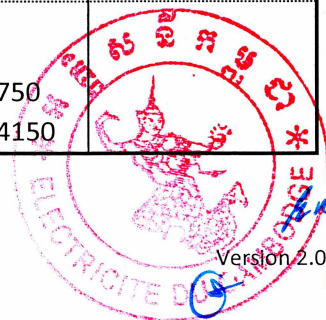
e.	The windings are designed and manufactured to resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
f.	MV and LV Windings are made with high conductivity copper and shall resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
g.	The insulation material of windings are suitable for the specified temperature rise and shall be thermally stabilized.		Yes	
h.	Vector group		Dyn 11 (IEC 60076)	
4.1	Primary for 35 kV transformers			
a.	Service voltage (Un)	kV	35	
b.	Rated maximum voltage (Um)	kV	38 or 40.5	
c.	Power frequency withstand voltage (1 mn)	kV	70	
d.	Rated impulse Voltage (1.2/50 μ s)	kV	170	
e.	Frequency	Hz	50	
4.2	Primary for 35(22) kV transformers			
a.	Service voltage (Un)	kV	35 (22)	
b.	Rated maximum voltage (Um)	kV	38 or 40.5	
c.	Power frequency withstand voltage (rms)	kV	70	
d.	Rated impulse Voltage (1.2/50 μ s)	kV	170	
e.	Frequency	Hz	50	
4.3	Secondary			
a.	Service voltage (Un)	kV	0.230/0.400	
b.	Rated Maximum Voltage (Um)	kV	1	
c.	Power frequency withstand voltage (rms)	kV	3	



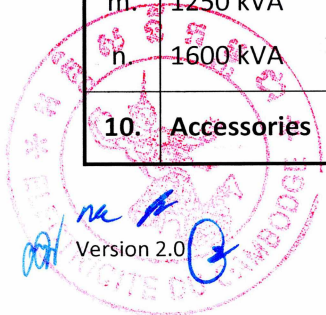
5.	Impedance voltage on the nominal voltage principal tap			To be specified
a.	50 and 75 kVA transformers		4%	
b.	Transformers from 100 to 315 kVA		4.5%	
c.	From 400 to 1000 kVA		5%	
d.	More than 1000 kVA		6%	
e.	The impedance voltage is subjected to the tolerance specified in IEC 60076.		Yes	
6.	Short-circuit performance			
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 sec with $I = I_{\text{rated}} \times 100 / U_k\%$,		To be specified	
7.	Tap changer			
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.	* For urban area , the tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%, * For remote rural area , the tap setting shall be: +2.5%, 0%, -2.5%, -5%, -7.5%		<input type="checkbox"/> <input type="checkbox"/>	
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.	For 35 (22) kV transformers, the high voltage windings are provided with 2			

	<p>position off-load voltage changer for primary voltage changing.</p> <p>The lever for operating the voltage changer is of externally operated type and shall be made by non-corrosive metal.</p>		<p>Yes</p> <p>Yes</p>	
f.	The tap or voltage changer position is indelibly marked by embossing or engraving and with weather proof paint		To be specified	
g.	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.	<p>50 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 170 ≤ 950 	
b.	<p>75 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 235 ≤ 1250 	
c.	<p>100 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 260 ≤ 1550 	
d.	<p>160 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 370 ≤ 2100 	
e.	<p>200 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 460 ≤ 2500 	
f.	<p>250 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 520 ≤ 2550 	
g.	<p>315 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 630 ≤ 3500 	
h.	<p>400 kVA</p> <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 750 ≤ 4150 	

M J L

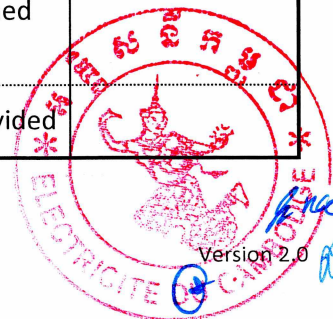


i.	500 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 900 ≤ 4950 	
j.	630 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 1050 ≤ 5850 	
k.	800 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 1270 ≤ 9900 	
l.	1000 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 1300 ≤ 12150 	
m.	1250 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 1530 ≤ 14850 	
n.	1600 kVA <ul style="list-style-type: none"> No load Load (75°C) 	W	<ul style="list-style-type: none"> ≤ 1850 ≤ 17850 	
9.	Acoustic sound Level			To be specified
a.	50 kVA	dB(A)	≤ 47	
b.	75 kVA	dB(A)	≤ 48	
c.	100 kVA	dB(A)	≤ 49	
d.	160 kVA	dB(A)	≤ 52	
e.	200 kVA	dB(A)	≤ 53	
f.	250 kVA	dB(A)	≤ 55	
g.	315 kVA	dB(A)	≤ 56	
h.	400 kVA	dB(A)	≤ 58	
i.	500 kVA	dB(A)	≤ 59	
j.	630 kVA	dB(A)	≤ 60	
k.	800 kVA	dB(A)	≤ 61	
l.	1000 kVA	dB(A)	≤ 63	
m.	1250 kVA	dB(A)	≤ 64	
n.	1600 kVA	dB(A)	≤ 66	
10.	Accessories			

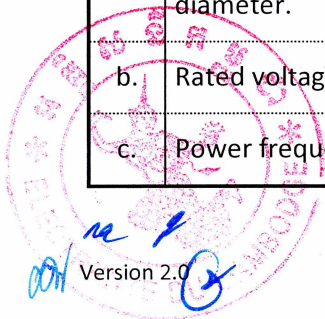



a.	The transformers are equipped with an overpressure relief device. The overpressure relief device is covered with a suitable "cover" to protect persons in the vicinity of the transformer against the spurting of hot oil in the event of an internal fault of the transformer		Yes	
b.	The transformers of 250 kVA and more 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 of 250 kVA and more are 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 technical characteristics -Mounting -Range (°C) -Accuracy -Ambient operating temperature (°C) -Protective index (IEC 60529) -Suitably protected against corrosion		Top mounted 20 to 120 ± 2% 0 to 60 IP 55 Yes	
e.	All other transformer necessary accessories are supplied with the transformer		Yes	
10.1	Surface treatment			
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	

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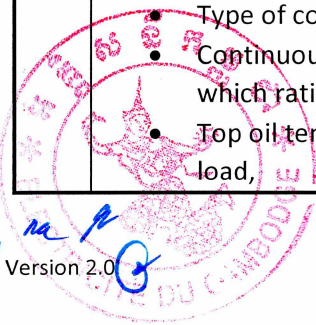


d.	Corrosion protection method		To be provided	
e	Paint salt spray test or equivalent proving paint lifespan		To be provided	
10.2	Primary bushings			
a.	-Porcelain bushings conform to the requirement of IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression -Aluminum/copper bimetallic lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
b.	Located on the top cover		Yes	
c.	Rated maximum voltage (Um)	kV	38 or 40.5	
d.	Creepage distance (min)	mm	950	
e.	Power frequency withstand voltage (rms)	kV	70	
f.	Rated impulse withstand voltage (1.2/50µs)	kV	170	
10.4	Secondary bushings			
1.	50, 75, 100 and 160 kVA transformers: -Porcelain bushings located on the tank cover or on the upper part of the right or left side of the transformer tank Tested according IEC 60137 -Brown color -Manufacturer and year indelible marking -Threaded parts and screws of metric sizes -Terminals suitable to received compression 150 mm ² aluminum/copper lugs for insulated conductor with a hole of 13 mm diameter.		Yes	
b.	Rated voltage		1 kV	
c.	Power frequency withstand voltage (rms)		3 kV	



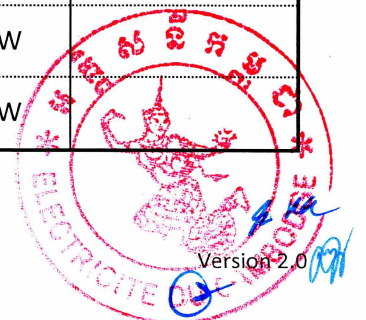
<p>2.</p>	<p>200, 250 and 315 kVA transformers</p> <ul style="list-style-type: none"> - Porcelain bushings are located on the tank top cover - LV bushings are equipped with terminal pad connectors made of high conductivity copper/bronze and hot-tin dipped. The tin thickness shall not be less of 8 micron (μm). - Bushings are aligned on the tank cover - Each pad is suitable to received two bi-metallic pre-insulated compression aluminum/copper lugs for 150 mm² Aluminum ABC with a hole of 13 mm diameter. - Threaded parts and screws are of metric sizes and protected against corrosion. - Each hole is fitted with one M12x60mm stainless steel or copper bolt including one nut, two flat washers and one lock washer. 		<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p>	
<p>a.</p>	<p>Rated voltage</p>		<p>1 kV</p>	
<p>b.</p>	<p>Withstand voltage (50 Hz, 1 mn)</p>		<p>3 kV</p>	
<p>3.</p>	<p>400 kVA and more transformers:</p> <ul style="list-style-type: none"> -LV bushings shall be equipped with terminal pad connectors of high conductivity copper/bronze and hot-tin dipped (8 μm). -Pad drilling according to NEMA or EN 50387 or EDF HN 52S62 or equivalent standard -Bushings aligned on the tank cover -It is possible to connect copper insulated 1x240mm² cables fitted with compression lugs with a 13mm diameter holes and according the requirements here in after: <ul style="list-style-type: none"> • 400 kVA : Two cables for each phase and one cable for neutral • 500, 630 kVA : Three cables for each phase and two cables for neutral • 800, 1000 kVA : Four cables for each phase and two cables for neutral 		<p>Yes</p> <p>To be specified</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p>	

	<ul style="list-style-type: none"> • 1250 kVA : Five cables for each phase and two cables for neutral • 1600 kVA : Six cables for each phase and three cables for neutral <p>M12x60 copper or stainless-steel bolts provided + one nut, two flat washers and one lock washer.</p>		Yes	
			Yes	
			Yes	
a.	Rated maximum voltage (Um)	kV	1	
b.	Power frequency withstand voltage (rms)	kV	3	
c.	Optional: LV insulation for LV bushing and connection protection box IP 2X		<input type="checkbox"/>	
10.5	Terminal permanent marking:			
a.	Primary : A, B, C		Yes	
b.	Secondary : a, b, c and n		Yes	
10.6	Label and rating plates			
	-Markings and instructions are clear and indelible and both in English and Khmer language		Yes	
	-Rating plate is embossed or engraved on weather proof rating plate with the following:			
	<ul style="list-style-type: none"> • 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, 		Yes	

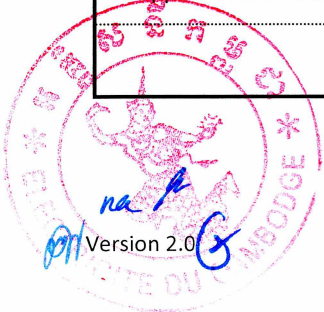


	<ul style="list-style-type: none"> • Total weight, • Volume of oil, • Weight of core and windings, • Table of primary voltages at the 5 tapping positions, • Connection diagram. • Property of ELECTRICITE DU CAMBODGE and EDC logo • កម្មសិទ្ធិអគ្គិសនីកម្ពុជា 			
a.	plate or paint marking mentioning kVA rating in numerals 70 mm height on the tank and below the MV bushing.		Yes	
10.7	Oil			
a.	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	
10.8	Transformer dimensions			To be specified
a.	50 kVA	mm	H x L x W	
b.	75 kVA	mm	H x L x W	
c.	100 kVA	mm	H x L x W	
d.	160 kVA	mm	H x L x W	
e.	200 kVA	mm	H x L x W	
f.	250 kVA	mm	H x L x W	
g.	315 kVA	mm	H x L x W	
h.	400 kVA	mm	H x L x W	
i.	500 kVA	mm	H x L x W	
j.	630 kVA	mm	H x L x W	
k.	800 kVA	mm	H x L x W	
l.	1000 kVA	mm	H x L x W	

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m.	1250 kVA	mm	H × L x W	
n.	1600 kVA	mm	H × L x W	
10.9	Transformer weight			
a.	50 kVA	kg	To be specified	
b.	75 kVA	kg	To be specified	
c.	100 kVA	kg	To be specified	
d.	160 kVA	kg	To be specified	
e.	200 kVA	kg	To be specified	
f.	260 kVA	kg	To be specified	
g.	315 kVA	kg	To be specified	
h.	400 kVA	kg	To be specified	
i.	500 kVA	kg	To be specified	
j.	630 kVA	kg	To be specified	
k.	800 kVA	kg	To be specified	
l.	1000 kVA	kg	To be specified	
m.	1250 kVA	kg	To be specified	
n.	1600 kVA	kg	To be specified	
11	Typical drawings of transformers including drawing of bushings.		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:

MS LL



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:

$$G \text{ (USD)} = \underline{A} \times \text{load loss (kW)} + \underline{B} \times \text{no-load loss (kW)}$$

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.

