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ELECTRICITE DU CAMBODGE

TECHNICAL SPECIFICATION

EDC-DTS-MV021

22kV Three Phase Indoor Dry Type Distribution Transformers


February 2022

001





ELECTRICITE DU CAMBODGE

Version	Date	Technical Specification Name	Authorized by : (name and signature)
1.0	May, 2022	22kV Three Phase Indoor Dry Type Distribution Transformers	 Dr. PRAING CHULASA



EDC-DTS-MV021 22kV Three Phase Indoor Dry Type Distribution Transformers

Version	Drafted/reviewed by	Verified by	Approved by	Date
Draft 1	AD			November 2021
Final 1	EDC/AD			December 2021
Final 2	EDC/Manufacturers/AD			February 2022



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22kV Three Phase Indoor Dry Type Distribution Transformers

1 Scope

This specification covers the design, manufacturing, testing, supply, delivery and performance requirements 3 phase, dry type distribution transformers for 22 KV level to be used on the Power Distribution networks of EDC with a life expectancy of at least 25 years without any maintenance in normal conditions.

These dry type transformers with cast resin technology shall be used in areas or building where fire is very sensitive as schools, buildings, chemical factories, hospitals, etc.

As the cast resin technology dry transformers are to be connected on EDC network, private customers who want or need to install such dry type transformer must respect this technical specification.

All dry type transformers will be supplied with metallic protection enclosure.

2 Standards

IEC : International Electro technical Commission

IEC 60071 : Insulation coordination

IEC 60076-1 : Power Transformers General

IEC 60076-2 : Temperature Rise

IEC 60076-3 : Power transformers insulation levels, dielectric tests and external clearances in air

IEC 60076-4 : Power transformer guide to the lightning impulse and switching impulse testing power transformers and reactors

IEC 60076-5 : Power transformers ability to withstand short circuit

IEC 60076-11 : Power transformers dry-type transformers

IEC 60076-12 : Load guide for dry-type power transformers

ISO : International Standard Organization

ISO 2063 : Metallic coating-protection of iron and steel against corrosion

ISO/IEC 17025 : General requirements for the competence of testing and calibration laboratories

ISO 9001 : Quality management systems – Requirements

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



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

3 Definitions

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

4 Testing and inspection

4.1 General Notes for Test

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

The inspection and routine tests shall be carried out in accordance with the provisions of the relevant IEC 60076-11 recommendations.

The transformers shall be subjected to test as specified below.

4.2 Type Tests

All type tests required by the IEC 60076-11 shall be carried out.

Type test reports or certification **of similar transformers (same technology)** shall be carried out by internationally recognized electrical testing laboratories.

Full copies of type test reports or test certification shall be submitted within the bid of the manufacturer/supplier. Type test reports or test certification 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.

Type tests shall be attached with the offer. Acceptability of any accredited testing laboratory is at the discretion of the EDC.

Failure of submitting type tests reports or type test certificates shall result in the rejection of the offer.

4.3 Routine Tests

The routine tests requested by IEC 60076-11 shall be carried out on all transformers.

Routine test reports shall be sent to EDC prior the shipment for EDC acceptance.

The following Routine tests reports shall be supplied:

- Measurement of windings resistance
- Measurement of voltage ratio and check of phase displacement



- Measurement of impedance voltage and load loss
- Measurement of no load loss and no load current
- Applied voltage test
- Induced voltage withstand test
- Partial discharges measurement. For this measurement, the acceptance criterion will be:
 - Partial discharges less than or equal to 10 pC at 1.30 Un.
 - Partial discharges less than or equal to 5 pC at 1.30 Un (Performance test)

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 and special tests procedures to be carried out during EDC approval inspection shall be sent to EDC for approval.

5 Quality Management

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

6 Technical requirements

6.1 General

22 kV Dry Type Distribution Transformers shall be 3 phase, 2 windings, dry type, 50 Hz and shall have off circuit tapings mounted in the primary winding.

They shall be of vacuum cast resin technology.

The type of cooling shall be air natural (AN).

Nevertheless, if according the local ambient conditions the manufacturer wishes to propose air forced cooling (AF) the fans shall not operate up to 50% of the transformer rated capacity and operate for more than 50% of the transformer rated capacity.

6.2 Voltage rating

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

- Primary voltage: Un: 22kV Um 24kV
- Secondary voltage: 230 / 400 Volts

7 Performance Characteristics

7.1 Ambient conditions

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

Altitude	Sea level to 1,000 meters
Climate	Tropical
Annual Rainfall	1,300 mm.140 days
Monsoon Period	June to November



Ambient Air Temperatures:	
Average	27.5°C
Minimum	13.3°C
Maximum	40.5°C
Relative Air Humidity	65-100%
Soil Thermal Resistivity:	
Average	1.20c m/W
Maximum	3.00c m/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)

It is remembered that the relative air humidity can be more than 93% mentioned in IEC 60076-11.

Additionally, normal temperatures in Cambodia are higher than the requested maximum temperatures mentioned in the same IEC.

These conditions must be taken into consideration for the dry type transformer offered.

7.2 Rated capacity

The continuous rating of the Distribution Transformers shall be:

Primary Voltage	Secondary Voltage	Rated Capacity
		kVA
22 kV	230/400 V	160, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150

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

Each transformer shall be capable of supplying its rated capacity continuously for all tap positions with rated voltage on the secondary winding and with the temperature's requirements mentioned in chapter 7.1

The transformers shall also be capable of delivering rated current at an applied voltage as per the requirements of IEC 60076-12.



7.3 Normal temperature-rise limits

The temperature rises of each winding of the transformer, designed for operation at normal service conditions, shall not exceed as follow (extract from IEC 60076-11 table 2):

Insulation system temperature (°C)	Average winding temperature rise limits at rated current (K)
155 (Class F)	100

The maximum temperature occurring in any part of the winding insulation system is called the hot-spot temperature. The hot spot temperature shall not exceed the rated value of the rated hotspot winding temperature of **155°C** specified in Table 1 of IEC 60076-12 with the maximum ambient temperature of 40.5 °C.

Likewise, each transformer shall be capable of supplying its rated capacity continuously under ambient temperature conditions.

7.4 Current and temperature limitations

With loading values beyond the nominal transformer rating, the hot-spot winding temperature shown of:

Insulation system temperature (°C)	155 (class F)
Maximum current (p.u.)	1.5 Ir
Highest temperature for hot-spot (°C)	180

As per Table 3 of IEC 60076-12 shall not be exceeded and the specific limitations given in chapters 4.3 and 5.12 of IEC 60076-12 shall be taken into account.

The current magnitude is limited to 1,5 Ir especially when the cycle is short and repeated to void mechanical damage in the winding.

The supplier shall include calculations demonstrating that these requirements are met.

8 Climatic, environmental and fire behavior classes

8.1 Climatic class

Transformers shall be of class C1:

Class C1: The transformer is suitable for operation at ambient temperature not below -5°C but may be exposed during transport and storage to ambient temperatures down to -25°C.

Special tests shall confirm the conformity of C1 class transformers shall be provided within the bid.

8.2 Environmental class

Environmental conditions for dry-type transformers are identified in terms of humidity, condensation, pollution and ambient temperature.

With regard to humidity, condensation and pollution, the environmental class of the supplied transformers shall be E2.

Class E2: Frequent condensation or heavy pollution or combination of both.



Special tests confirming the conformity of E2 class transformers shall be provided within the bid.

8.3 Fire behavior class

Transformers shall be of class F1:

Class F1: Transformers subject to a fire hazard. Restricted flammability is required. The emission of toxic substances and opaque smokes shall be minimized.

Special tests shall confirm the conformity of F1 class transformers shall be provided within the bid.

9 Technical Characteristics

9.1 Tapping

The high voltage windings shall be provided with a re-connectable tapping changing device on the high voltage side of the transformer which shall, when operated with a de-energized transformer, change the voltage ratio of the transformer.

The tapping device shall be durably structured and bar links and positions shall be clearly identifiable when selecting taps.

9.1.1 Voltage Ratio

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

The no load voltage ratios shall be:

Tap number	Secondary voltage 3 phases transformer	Primary voltage for 22kV winding
1	400 V	23 100 V
2	400 V	22 550 V
3	400 V	22 000 V
4	400 V	21 450 V
5	400 V	20 900 V

9.2 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 core frame shall include lifting lugs and shall be mounted on a base frame with anchor holes. All structural steels and cores shall be protected against corrosion with coat of epoxy paint or equivalent.

9.3 Winding

MV and LV Windings or foils shall be made with high conductivity **copper or aluminum** 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.



MV winding shall be mandatorily of vacuum cast resin technology. LV windings could be of vacuum cast resin technology or this LV winding can be made using conductor with pre-impregnated epoxy resin coating.

9.4 Vector group

The vector group of all distribution transformers shall be Dyn 11 in accordance with IEC 60076.

9.5 Connections

9.5.1 MV connections

MV connections shall be made using simplified MV cable terminations arriving from the floor of the substation.

Nevertheless, the transformer enclosure shall allow cables termination incoming from the top of the enclosure in order the transformer being install in any substation configuration.

Specific collars for fixing the cable at the base of termination onto the transformer frame shall be supplied.

In order to connect directly the termination lug onto the cast resin winding, this one shall include a pad made of copper and the necessary bolt shall be supplied with the transformer.

9.5.2 LV connection

LV connections shall be located on the top of the transformer and on the MV opposite side.

LV connections on the top of the transformer shall be of copper or tinned aluminum bars and fitted with all necessary holes for bus bar or cable lugs connection according the necessary number of LV cables of 240 sq mm aluminum core cables.

The bars 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 bars and copper insulated 1x240mm² cables fitted with compression lugs with a 13mm diameter hole and according the requirements here in after:

- 250 kVA : one cable for each phase and neutral or copper bars
- 400 kVA : Two cables for each phase and one cable for neutral or copper bars
- 630 kVA : Three cables for each phase and two cable for neutral or copper bars
- 1000 kVA : Four cables for each phase and two cables for neutral or copper bars
- 1250 kVA : Five cables for each phase and two cables for neutral or copper bars
- 1600 kVA : Six cables for each phase and three cables for neutral or copper bars
- 2000 kVA : eight cables for each phase and four cables for neutral or copper bars
- 2500 kVA : ten cables for each phase and five cables for neutral or copper bars
- 3150 kVA : twelve cables for each phase and six cables for neutral or copper bars

Each hole shall be fitted with one M12x60mm stainless steel or copper bolt including one nut, two flat washers and one lock washer.

9.6 Insulation levels

Power transformers shall be designed according the recommendations of IEC 60071-11 and tested to the following insulation levels:



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

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

9.7 Impedance Voltage

The impedance on the principal voltage position (22 000V) shall not be less than 6% for the whole range of transformers. 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.

9.8 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 2 seconds.

According to IEC 60076, all transformers shall have:

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

Where $U_k\%$ is the impedance voltage.

9.9 Partial discharge

The maximum level of transformer partial discharges shall be 10 pC.

Nevertheless, transformers offering partial discharge level of 5pC shall be accepted.

9.10 Losses

Transformers to be supplied will be of two types depending the wishes of the purchaser:

9.10.1 Normal losses level type:

The maximum values of losses accepted shall be as follows:

3 phase 22 kV Dry type Transformers		
Normal losses level		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 120 °C (W)
160	≤ 750	≤ 3 110
250	≤ 950	≤ 3 700
315	≤ 1 200	≤ 4 600
400	≤ 1 600	≤ 5 800



500	$\leq 1\ 600$	$\leq 6\ 700$
630	$\leq 1\ 850$	$\leq 7\ 800$
800	$\leq 2\ 150$	$\leq 9\ 300$
1000	$\leq 2\ 500$	$\leq 12\ 000$
1250	$\leq 2\ 900$	$\leq 13\ 000$
1600	$\leq 3\ 400$	$\leq 19\ 000$
2000	$\leq 4\ 200$	$\leq 23\ 000$
2500	$\leq 5\ 050$	$\leq 25\ 800$
3150	$\leq 6\ 300$	$\leq 28\ 000$

9.10.2 Low losses level type:

The maximum values of losses accepted shall be as follows:

3 phase 22 kV Dry type Transformers		
Low losses level		
Transformer capacity (kVA)	No-load Loss (W)	Load Loss at 120 °C (W)
160	≤ 420	$\leq 3\ 000$
250	≤ 530	$\leq 3\ 600$
315	≤ 690	$\leq 4\ 600$
400	≤ 760	$\leq 5\ 300$
500	$\leq 1\ 050$	$\leq 6\ 400$
630	$\leq 1\ 200$	$\leq 7\ 200$
800	$\leq 1\ 350$	$\leq 8\ 200$
1000	$\leq 1\ 600$	$\leq 9\ 100$
1250	$\leq 1\ 850$	$\leq 11\ 500$
1600	$\leq 2\ 300$	$\leq 13\ 300$
2000	$\leq 2\ 700$	$\leq 16\ 100$
2500	$\leq 3\ 200$	$\leq 19\ 000$
3150	$\leq 4\ 000$	$\leq 22\ 000$

Nevertheless, transformers with extra low losses level could be also provided.



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

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

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

Transformers of normal losses level that exceed the tolerances allowed by IEC 60076 will be rejected. Tolerances are not allowed for low losses level transformer.

9.11 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.

9.12 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.

9.13 Acoustic sound level

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

It shall not exceed:

Transformer Capacity kVA	Max Acoustic Sound level: dB(A)
160	58
250	60
315	62
400	63
500	64
630	65
800	67
1000	68
1250	69
1600	71
2000	73
2500	76
3150	80

10 Materials and Construction

10.1 Under frame

Each transformer shall include a metallic underframe solidly fixed to the core.

This under frame protected against corrosion by galvanizing or epoxy paint shall be delivered with four wheels in order to position the transformer in the substation.



The wheels shall be bidirectional for easy transformer positioning and "crossing" wheels when in final position.

10.2 Transformer enclosure

All transformers shall be delivered with a metallic enclosure protected against corrosion by hot dip galvanizing or epoxy paint. It can be made also with stainless steel.

This enclosure shall be mandatorily originated from the transformer manufacturer. If not, the offer shall be rejected. Nevertheless, enclosures for which design, development are made jointly by transformer manufacturer and another company (for manufacturing) are accepted provided the transformer manufacturer issue a letter or certificate certifying its agreement and acceptance.

This document shall be included within the offer.

It shall be possible to install the enclosure onto the transformer allowing installation of the transformer with its enclosure inside the substation. For that purpose, lifting-lugs enabling the transformer and enclosure assembly to be handled shall be provided.

The enclosure shall be provided assembled or not.

This robust enclosure shall allow the permanent airing of the transformer and shall be firmly fixed to the transformer in order to keep the necessary air insulating distance between live parts and metallic enclosure.

This enclosure shall be fitted with opening doors or dismountable sides in regards to the MV and LV connections.

The enclosure shall be fitted with specific gland plates located on the top for eventual MV cable incoming from the roof of the substation and specific gland plate on the top and the side of the enclosure for LV cables penetration inside the enclosure.

The enclosure shall be easy to install onto the transformer when inside a substation with a distance between roof and floor 3.5 m.

The IP index of the enclosure shall be IP 21 as a minimum.

10.3 Cooling

The cooling of the transformer installed in its enclosure shall be air natural (AN) as per IEC 60076-11.

Nevertheless, if according the local ambient conditions, the manufacturer wishes to propose air forced cooling (AF), the fans shall not operate up to 50% of the transformer rated capacity and operate for more than 50% of the transformer rated capacity.

10.4 Transformer lifting

Each transformer shall be provided with a minimum of two closed lifting lugs located on the top of the transformer. The minimum diameter of the hole shall be 25 mm.

10.5 Earthing

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

10.6 Thermal protection

These transformers will be equipped with a thermal protection device which will comprise at least:



- 3 thermal detection systems (1 by phase), installed in the active part of the transformer. The sensors shall be easy to be replaced if ever necessary.
- An electronic converter with two independent monitoring circuits equipped with a changeover switch, one for "Alarm 1" the other for "Alarm 2" and another one for tripping. The electronic converter will be installed away from the transformer; on the transformer enclosure as example.
- Clear indication of the transformer temperature

The sensors will be supplied assembled and wired to the terminal block fixed on the upper part of the transformer or directly to the converter. The converter will be supplied separated from the transformer, packaged complete with its wiring diagram.

10.7 Option: transformer monitoring device

As option, the transformer could be fitted with transformer monitoring device. This device shall analyze and provides data 24/7 on temperature and alarm either by internet link or SMS. The transformer temperature as well as the MV and LV connections temperature shall be monitored.

10.8 Terminal Marking

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

The distribution transformers shall be labelled as follows:

Primary voltage: A, B, C or 1U, 1V, 1W

Secondary voltage: a, b, c and n or 2U, 2V, 2W, 2N

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 fixed onto the transformer in accordance with IEC 60076-11 and showing the following items, indelibly marked by engraving or embossing:

- dry-type transformer;
- number and year of IEC 60076-11;
- manufacturer's name;
- manufacturer's serial number;
- year of manufacture;
- Insulation system temperature for each winding.
- number of phases;
- rated power for each kind of cooling (if any);
- rated frequency;
- Rated voltages,
- Rated currents,
- Vector group,
- Percentage impedance voltage at rated current,
- Type of cooling,
- Total Mass
- Insulation levels
- Degree of protection



- r) Environmental class; Climatic class; Fire behavior class
- s) Table of primary voltages at the 5 tapping positions
- t) Connection diagram

Property of ELECTRICITE DU CAMBODGE and EDC logo on Enclosure (only if transformer is purchased by EDC).

Similarly, and as requested by the IEC 60076-11, each transformer enclosure shall be provided with a rating plate of weatherproof material, fitted in a visible position, showing the items indicated above. The entries on the plate shall be indelibly marked (that is, by etching, engraving, stamping or by a photo-chemical process).

In addition, the enclosure shall be marked by "PROPERTY OF ELECTRICITE DU CAMBODGE" if the transformer is purchased by EDC.

The enclosure shall also bear the necessary warning signs.

12 Delivery

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

13 Technical data sheets



	Description	Unit	Requirement	Supplier's Offer
	22 kV Three phase CRT transformers			
1	Capacity	kVA	160 <input type="checkbox"/> 250 <input type="checkbox"/> 315 <input type="checkbox"/> 400 <input type="checkbox"/> 500 <input type="checkbox"/> 630 <input type="checkbox"/> 800 <input type="checkbox"/> 1000 <input type="checkbox"/> 1250 <input type="checkbox"/> 1600 <input type="checkbox"/> 2000 <input type="checkbox"/> 2500 <input type="checkbox"/> 3150 <input type="checkbox"/>	
2	Manufacturing Country		to be specified	
3	Manufacturer		to be specified	
4	Manufacturer's reference		to be specified	
5	Standard		IEC 60076-11	
6	Type test reports or test certification as per § 4.2 and IEC 60076		To be provided with bid.	
7	ISO 9001 for design, development and production		Yes. Certificate to be provided	
General				
8	Dry Type Transformers		Mandatory	
9	Indoor type		Yes	
10	Lifespan	year	≥ 25	
11	Withstand Ambient conditions in § 7.1		Mandatory	



Construction and physical characteristics				
12	Temperatures			
12a	Class	F		
12b	Insulation system temperature	(°C)	155	
12c	Average winding temperature rise limits at rated current	(K)	100	
12d	Rated hotspot-winding temperature at I_r with the maximum ambient temperature of 40.5 °C.	(°C)	155	
12c	Highest temperature for hot-spot at 1.5 I_r	(°C)	180	
12d	The current magnitude is limited to 1,5 I_r especially when the cycle is short and repeated to void mechanical damage in the winding. The supplier shall include calculations demonstrating that these requirements are met.		Yes To be provided	
13	Classes			
13a	Minimum temperature class		F	
13b	Minimum Climatic class		C1	
13c	Minimum Environment class		E2	
13d	Minimum Fire class		F1	
14	Tapping			
14a	The high voltage windings shall be provided with a re-connectable tapping changing device on the high voltage side of the transformer which shall, when operated with a de-energized transformer, change the voltage ratio of the transformer.		Yes	
14b	The tapping device shall be durably structured and bar links and positions shall be clearly identifiable when selecting taps.		Yes	
14c	Each transformer shall be fitted with 5 taps giving provision for off circuit changing of voltage ratio; The tap settings shall be +5%, +2.5%, 0%, -2.5%, -5%,		Mandatory	
14d	Voltage ratio with 400V at secondary Tap 1	V	23 100	



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	Tap 2	V	22 550	
	Tap 3	V	22 000	
	Tap 4	V	21 450	
	Tap 5	V	20 900	
14c	Core			
	Core are made of low loss, high permeability material		Yes	
	The core construction avoids static discharge and development of short-circuit paths within itself or to the ground.		Yes	
	The core design ensures no hot sections due to over fluxing or circulating currents.		Yes	
	The core frame includes lifting lugs and are mounted on a base frame with anchor holes.		Yes	
	All structural steels and cores are protected against corrosion with coat of epoxy paint or equivalent.		To be mentioned	
14d	Winding			
	MV and LV Windings or foils are made with high conductivity		copper or aluminum	Copper <input type="checkbox"/> Aluminum <input type="checkbox"/>
	They are designed and manufactured to resist, without suffering damage, the thermal and mechanical effects caused by external short-circuit.		Yes	
	The insulation material of windings shall be suitable for the specified temperature rise and shall be thermally stabilized.		Mandatory	
	MV winding are of vacuum cast resin technology.		Mandatory	
	LV windings could be of vacuum cast resin technology or this LV winding can be made using conductor with pre-impregnated epoxy resin coating.			Vacuum <input type="checkbox"/> Pre-impregnated <input type="checkbox"/>
14e	Vector group		Dyn 11	



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14f	Primary voltage			
	Service Voltage	kV	22	
	Rated Maximum Voltage	KV	24	
	Power frequency withstand voltage (50Hz/1 mn)	kV	50	
	Rated impulse withstand voltage (1.2/50μs)	kV	125	
14g	Secondary voltage			
	Service Voltage	kV	0.4	
	Rated Maximum Voltage	kV	1	
	Power frequency withstand voltage (50Hz/1 mn)	kV	3	
14h	Impedance voltage on the principal voltage position (22 000V) is not less than: 6%		To be mentioned	160 : 250 : 315 : 400 : 500 : 630 : 800 : 1000 : 1250 : 1600 : 2000 : 2500 : 3150 :
14i	Short circuit performance The transformers are 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, all transformers shall have:		Yes	



	<ul style="list-style-type: none"> a thermal withstanding to short circuit of 2 s. a mechanical withstanding to short circuit of 0.5 s with $I = I_{\text{rated}} \times 100 / U_k\%$, Where $U_k\%$ is the impedance voltage. 		Yes	
14j	Partial discharge The maximum level of transformer partial discharges shall be 10 pC. Nevertheless, transformers offering partial discharge level of 5pC are accepted.		Yes	10 pC <input type="checkbox"/> 5 pC <input type="checkbox"/>
15	NORMAL LOSSES LEVEL TRANSFORMER <input type="checkbox"/>			
15 a	No load losses			Value to be mentioned
	160 kVA		≤ 750	
	250 kVA		≤ 950	
	315 kVA		$\leq 1\,200$	
	400 kVA		$\leq 1\,600$	
	500 kVA	W	$\leq 1\,600$	
	630 kVA		$\leq 1\,850$	
	800 kVA		$\leq 2\,150$	
	1000 kVA		$\leq 2\,500$	
	1250 kVA		$\leq 2\,900$	
	1600 kVA		$\leq 3\,400$	
	2000 kVA		$\leq 4\,200$	
	2500 kVA		$\leq 5\,050$	
	3150 kVA		$\leq 6\,300$	
15b	Load losses at 120°C			Value to be mentioned
	160 kVA		$\leq 3\,100$	
	250 kVA		$\leq 3\,700$	
	315 kVA		$\leq 4\,600$	
	400 kVA		$\leq 5\,800$	



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EDC-DTS-MV021 22kV Three Phase Indoor Dry Type Distribution Transformers

	500 kVA	W	$\leq 6\,700$	
	630 kVA		$\leq 7\,800$	
	800 kVA		$\leq 9\,300$	
	1000 kVA		$\leq 12\,000$	
	1250 kVA		$\leq 13\,000$	
	1600 kVA		$\leq 19\,000$	
	2000 kVA		$\leq 23\,000$	
	2500 kVA		$\leq 22\,800$	
	3150 kVA		$\leq 28\,000$	
16	LOW LOSSES LEVEL TRANSFORMER <input type="checkbox"/>			
16a	No load losses			Value to be mentioned
	160 kVA		≤ 420	
	250 kVA		≤ 530	
	315 kVA		≤ 690	
	400 kVA		≤ 760	
	500 kVA		$\leq 1\,050$	
	630 kVA		$\leq 1\,200$	
	800 kVA	W	$\leq 1\,350$	
	1000 kVA		$\leq 1\,600$	
	1250 kVA		$\leq 1\,850$	
	1600 kVA		$\leq 2\,300$	
	2000 kVA		$\leq 2\,700$	
	2500 kVA		$\leq 3\,200$	
	3150 kVA		$\leq 4\,000$	
16b	Load losses at 120°C			Value to be mentioned
	160 kVA		$\leq 3\,000$	
	250 kVA		$\leq 3\,600$	
	315 kVA		$\leq 4\,600$	
	400 kVA		$\leq 5\,300$	
	500 kVA		$\leq 6\,400$	



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	630 kVA	W	$\leq 7\ 200$	
	800 kVA		$\leq 8\ 200$	
	1000 kVA		$\leq 9\ 100$	
	1250 kVA		$\leq 11\ 500$	
	1600 kVA		$\leq 13\ 300$	
	2000 kVA		$\leq 16\ 100$	
	2500 kVA		$\leq 19\ 000$	
	3150 kVA		$\leq 22\ 000$	
17	Over fluxing The transformers are 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.		Yes	
18	Noise level 160 kVA 250 kVA 315 kVA 400 kVA 500 kVA 630 kVA 800 kVA 1000 kVA 1250 kVA 1600 kVA 2000 kVA 2500 kVA 3150 kVA	dB	≤ 58 ≤ 60 ≤ 62 ≤ 63 ≤ 64 ≤ 65 ≤ 67 ≤ 68 ≤ 69 ≤ 71 ≤ 73 ≤ 76 ≤ 80	Value to be mentioned
19	MV connections MV connections are made using simplified MV cable terminations arriving from the floor of the substation.		Mandatory	



	<p>Nevertheless, the transformer enclosure shall allow cables termination incoming from the top of the enclosure in order the transformer being install in any substation configuration.</p> <p>Specific collars for fixing the cable at the base of termination onto the transformer frame are supplied.</p> <p>In order to connect directly the termination lug onto the cast resin winding, this one shall include a pad made of copper and the necessary bolt shall be supplied with the transformer.</p>		<p>Yes</p> <p>Yes</p> <p>Yes</p>	
20	<p>LV connection</p> <p>LV connections are located on the top of the transformer and on the MV opposite side.</p> <p>LV connections on the top of the transformer shall be of copper or tinned aluminum bars and fitted with all necessary holes for cable lugs connection according the necessary number of LV cables of 240 sq mm copper core cables.</p> <p>The bars shall be drilled in accordance with NEMA or EN 50387 or EDF HN 52S62 standards or any equivalent standard provided it shall be possible to connect copper insulated 1x240mm² cables fitted with compression lugs with a 13mm diameter hole and according the requirements here in after:</p> <p>250 kVA: one cable for each phase and neutral or copper bars</p> <p>400 kVA: Two cables for each phase and one cable for neutral or copper bars</p> <p>630 kVA: Three cables for each phase and two cable for neutral or copper bars</p> <p>1000 kVA: Four cables for each phase and two cables for neutral or copper bars</p>		<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p>	



	1250 kVA: Five cables for each phase and two cables for neutral or copper bars		Yes	
	1600 kVA: Six cables for each phase and three cables for neutral or copper bars		Yes	
	2000 kVA: eight cables for each phase and four cables for neutral or copper bars		Yes	
	2500 kVA: ten cables for each phase and five cables for neutral or copper bars		Yes	
	3150 kVA: twelve cables for each phase and six cables for neutral or copper bars		Yes	
21	<p>Terminal Marking</p> <p>The terminal markings are clearly and permanently displayed. Painted markings are not acceptable.</p> <p>Primary voltage:</p> <p>Secondary voltage:</p>		<p>Yes</p> <p>A, B, C or 1U, 1V, 1W</p> <p>a, b, c and n or 2U, 2V, 2W, 2N</p>	
22	Materials and Construction			
22a	<p>Under frame</p> <p>Each transformer includes a metallic underframe solidly fixed to the core.</p> <p>This under frame protected against corrosion by galvanizing or epoxy paint</p> <p>Under frame includes four wheels</p> <p>The wheels are bidirectional</p>		<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Mandatory</p>	
22b	<p>Transformer enclosure</p> <p>All transformers are delivered with a metallic enclosure protected against corrosion by hot dip galvanizing or epoxy paint. It can be made also with stainless steel.</p>		Mandatory	<p>Galvanizing <input type="checkbox"/></p> <p>Epoxy paint <input type="checkbox"/></p> <p>Stainless steel <input type="checkbox"/></p> <p>Other <input type="checkbox"/> to be mentioned</p>
	<p>This enclosure shall be mandatorily originated from the transformer manufacturer. If not, the offer shall be rejected. Nevertheless, enclosures for which design, development are made jointly by transformer manufacturer and another company (for manufacturing) are</p>			



	<p>accepted provided the transformer manufacturer issue a letter or certificate certifying its agreement and acceptance.</p> <p>This document shall be included within the offer.</p>		
	<p>It shall be possible to install the enclosure onto the transformer allowing installation of the transformer with its enclosure inside the substation.</p> <p>For that purpose, lifting-lugs enabling the transformer and enclosure assembly to be handled shall be provided.</p> <p>The enclosure shall be provided not assembled.</p> <p>This robust enclosure shall allow the permanent airing of the transformer and shall be firmly fixed to the transformer in order to keep the necessary air insulating distance between live parts and metallic enclosure.</p> <p>This enclosure shall be fitted with opening doors or dismountable sides in regards to the MV and LV connections.</p> <p>The enclosure shall be fitted with specific gland plates located on the top for eventual MV cable incoming from the roof of the substation and specific gland plate on the top and the side of the enclosure for LV cables penetration inside the enclosure.</p> <p>The enclosure shall be easy to install onto the transformer when inside a substation with a distance between roof and floor of 3.5 meters.</p> <p>IP index of the enclosure</p>	<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>≤ IP 21</p>	
22c	<p>Cooling</p> <p>The cooling of the transformer installed in its enclosure shall be air natural (AN) as per IEC 60076-11.</p> <p>Nevertheless, if according the local ambient conditions, the manufacturer wishes to propose air forced cooling (AF), the fans shall not operate up to 50% of the transformer rated capacity and operate for</p>	<p>To be mentioned</p>	<p>AN <input type="checkbox"/></p> <p>AF 50% <input type="checkbox"/></p>



	more than 50% of the transformer rated capacity.			
22d	Transformer lifting			
22e	Each transformer is provided with a minimum of two closed lifting lugs located on the top of the transformer. Diameter of lugs hole	mm	Mandatory 25	
22f	Earthing Two 10 mm diameter hole for connection of earth wires copper lug are provided on the transformer under frame. Those holes are located on each lower side of the transformer.		Yes Yes	
23	Thermal protection Transformers are equipped with a thermal protection device It includes at least: • 3 thermal detection systems (1 by phase), installed in the active part of the transformer. The sensors shall be easy to be replaced if ever necessary. The sensors are supplied assembled and wired to the terminal block (or directly to the converter) fixed on the upper part of the transformer. • An electronic converter with two independent monitoring circuits equipped with a changeover switch, one for "Alarm 1" the other for "Alarm 2" and another one for tripping. The electronic converter will be installed away from the transformer; on the transformer enclosure as example. • Clear indication of the transformer temperature. The converter is supplied separated from the transformer, packaged complete with its wiring diagram.		Mandatory Mandatory Mandatory Mandatory Mandatory Mandatory Yes	



24	<p>Transformer monitoring device</p> <p>As option, the transformer could be fitted with transformer monitoring device. This device shall analyze and provides data 24/7 on temperature and alarm either by internet link or SMS. The transformer temperature as well as the MV and LV connections temperature shall be monitored.</p>		Yes <input type="checkbox"/> No <input type="checkbox"/>	
25	<p>Markings</p> <p>Labels, plates, markings and instructions are clear and indelible and both in English and Khmer language.</p> <p>Case-in or molded-in words which are not English words are covered with permanently fixed non-ferrous labels inscribed in English.</p> <p>A weatherproof rating plate is fixed onto the transformer in accordance with IEC 60076-11 and showing the following items, indelibly marked by engraving or embossing:</p> <p>a) dry-type transformer;</p> <p>b) number and year of IEC 60076-11;</p> <p>c) manufacturer's name;</p> <p>d) manufacturer's serial number;</p> <p>e) year of manufacture;</p> <p>f) Insulation system temperature for each winding.</p> <p>g) number of phases;</p> <p>h) rated power for each kind of cooling;</p> <p>i) rated frequency;</p> <p>j) Rated voltages,</p> <p>k) Rated currents,</p> <p>l) Vector group,</p> <p>m) Percentage impedance voltage at rated current,</p> <p>n) Type of cooling,</p> <p>p) Total Mass</p>		<p>Mandatory</p> <p>Yes</p> <p>Mandatory</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p>	



	<p>q) Insulation levels</p> <p>r) Degree of protection</p> <p>s) Environmental class; Climatic class; Fire behavior class</p> <p>t) Table of primary voltages at the 5 tapping positions</p> <p>u) Connection diagram</p> <p>Property of ELECTRICITE DU CAMBODGE and EDC logo on Enclosure (only if transformer is purchased by EDC).</p> <p>Similarly, and as requested by the IEC 60076-11, each transformer enclosure shall be provided with a rating plate of weatherproof material, fitted in a visible position, showing the items indicated above. The entries on the plate shall be indelibly marked (that is, by etching, engraving, stamping or by a photo-chemical process).</p> <p>In addition, the enclosure shall be marked by "PROPERTY OF ELECTRICITE DU CAMBODGE" if the transformer is purchased by EDC.</p> <p>The enclosure shall also bear the necessary warning signs.</p>		<p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p> <p>Mandatory</p> <p>Mandatory</p> <p>Mandatory</p> <p>To be mentioned</p>	
26	<p>Transformer Dimensions</p> <p>160 kVA</p> <p>250 kVA</p> <p>315 kVA</p> <p>400 kVA</p> <p>500 kVA</p> <p>630 kVA</p> <p>800 kVA</p> <p>1000 kVA</p> <p>1250 kVA</p> <p>1600 kVA</p> <p>2000 kVA</p>	mm	<p>L x H x W</p> <p>To be mentioned</p>	



	2500 kVA 3150 kVA			
27	Transformer Weight 160 kVA 250 kVA 315 kVA 400 kVA 500 kVA 630 kVA 800 kVA 1000 kVA 1250 kVA 1600 kVA 2000 kVA 2500 kVA 3150 kVA	Kg	To be mentioned	
28	Enclosure dimensions 160 kVA 250 kVA 315 kVA 400 kVA 500 kVA 630 kVA 800 kVA 1000 kVA 1250 kVA 1600 kVA 2000 kVA 2500 kVA 3150 kVA	mm	L x H x W To be mentioned	



29	Enclosure weight			
	160 kVA			
	250 kVA			
	315 kVA			
	400 kVA			
	500 kVA			
	630 kVA	kg	To be mentioned	
	800 kVA			
	1000 kVA			
	1250 kVA			
	1600 kVA			
	2000 kVA			
	2500 kVA			
	3150 kVA			
30	Typical drawings of transformers.		To be supplied with bid	
31	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, ", 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/

Full technical information shall be supplied within the bid. If not, the offer shall not be considered.

Bidder signature:

