



THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS  
WITH ABILITY TO WITHSTAND SHORT CIRCUIT

Specification No. RTRN-035/2561

Approved date : 30/05/2562

Rev. No. : 5

Form No. 02-3S

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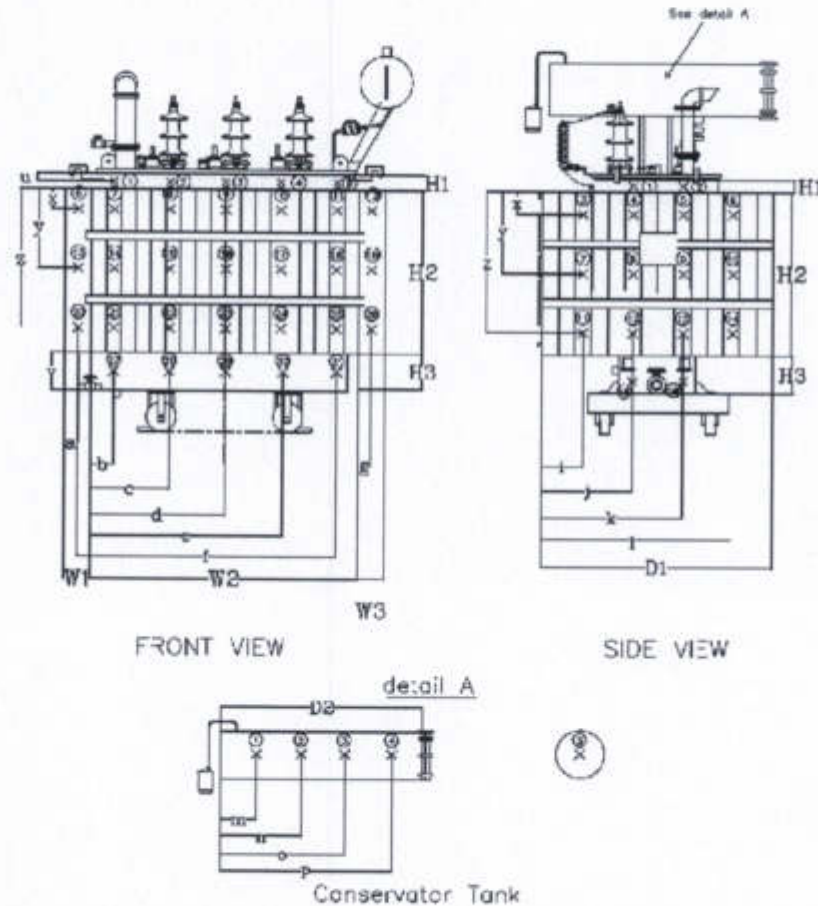


Figure 3 The position for spot checking for transformers of conservator system type.

The distance for spot checking of conservator system type is as Table 9:

Table 9 Distance for spot checking of conservator system type

Symbols	Length	Symbols	Length
a	About 1/2 of height (W1)	m	About 1/5 of depth (D2)
b	About 1/6 of height (W2)	n	About 2/5 of depth (D2)
c	About 2/6 of height (W2)	o	About 3/5 of depth (D2)
d	About 3/6 of height (W2)	p	About 4/5 of depth (D2)
e	About 4/6 of height (W2)	u	About 1/2 of height (H1)
f	About 5/6 of height (W2)	v	About 1/4 of width (H3)
g	About 1/2 of height (W3)	x	About 1/4 of width (H2)
i	About 1/5 of depth (D1)	y	About 2/4 of width (H2)
j	About 2/5 of depth (D1)	z	About 3/4 of width (H2)
k	About 3/5 of depth (D1)		
l	About 4/5 of depth (D1)		

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The bidders have to submit the test report, conducted by the acknowledged testing laboratories or manufacture, with the bid. The Item offered without submitting the dry film thickness test report shall be rejected.

**The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.**

**1c.12.2 Dry film thickness test report**

The required information in dry film thickness test report shall be at least the following items:

- (1) Transformer information
  - 1) Manufacturer's name
  - 2) Model
  - 3) Serial number
  - 4) Number of phase
  - 5) Rated voltage of the high-voltage winding
  - 6) Rated voltage of the low-voltage winding
  - 7) Rated frequency
  - 8) Rated power
  - 9) Rated current of the high-voltage winding
  - 10) Rated current of the low-voltage winding
- (2) Painted information
  - 1) Coating system (flow coating or spraying)
  - 2) The information for each coating (Primer coat, Subsequent coat, Top coat) minimum as following:
    - Type of material
    - Paint Manufacturer
    - Require minimum dry film thickness ( $\mu\text{m}$ ) as specified
    - Actual dry film thickness ( $\mu\text{m}$ ) (3 reading per 1 spot checks)
  - 3) Technical Data of coats
  - 4) Painting Procedure

**1c.12.3 Acceptance test procedure of dry film thickness test**

The total dry film thickness of coating shall be measured by contractor for acceptance testing and witness by the PEA's acceptance committee. Total dry film thickness shall be not less than 160  $\mu\text{m}$  according to ISO 12944-5. PEA will randomly select the samples of transformer only from the first lot. The number of samples and criteria for consideration shall be according to **Table 10**.

PEA reserve the right to send representative to inspect and witness test.

**The cost of all tests and reports shall be borne by the manufacturers/contractor.**





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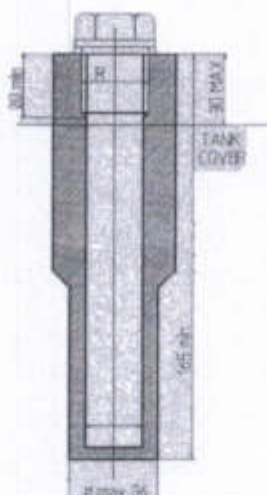
**1c.13 Marking**

PEA's code number and word "SHORT CIRCUIT WITHSTAND" shall be painted, in orange, on the transformer tank (for transformer having no conservator) or on the conservator tank (for transformer having conservator) at the position that enables a clear observation, and also be legibly and durably inscribed on the metal part of nameplate. The code number and dimensions of each letter to be marked shall be given by PEA after the final of bid consideration.

**1c.14 Accessories**

The 50 kVA to 2,000 kVA transformers shall be furnished and equipped with the following accessories:

1. HV and LV bushings, with terminal connectors
2. Bird guard cap (bushing cover), ultra-violet and track resistant material, e.g. polypropylene, neoprene, etc; which is suitable for exposure to sunlight
3. Earthing terminal for surge arrester, with solderless clamp type connector suitable for flexible copper insulated ground lead size  $16 \text{ mm}^2$ , 430 mm long. (See Drawing No. SA4-015/50008)
4. Tap changer
5. Thermometer pocket, transformers shall have a thermometer pocket to allow the measuring of the top-oil temperature. This pocket shall be placed as shown in the EN 50216-4 (type A1). The pocket shall be provided with a corrosion-proof cap. The thread shall be protected with silicone-grease. Dimensions of the thermometer pocket in mm are shown as **Figure 4**.



**Figure 4 Dimensions of thermometer pockets**

6. Nameplate with connection diagram
7. Oil drain valve with plug or cap, installed at the lower part of the tank
8. Sludge drain plug, installed at the bottom of the tank



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9. Earthing terminal, with solderless clamp type connector suitable for steel stranded conductor diameter of 9.0 mm (size 50 mm<sup>2</sup>); complete with lockwasher of stainless steel or better.
10. Lifting lugs
11. Lifting eyes on the cover
12. Oil level gauge
13. Compression type cable lug, for aluminium conductor diameter of 7.5-9.0 mm (sizes 35-50 mm<sup>2</sup>), suitable for connecting between HV bushing and surge arrester lead conductor.
14. Only for 50 kVA to 250 kVA transformers: Pressure relief valve on the tank cover, oil filling plug on the tank cover, and supporting lugs for hanging the transformer tank to pole by using two (2) M16 machine bolts.  
The lugs shall have 600 mm spacing; 500 mm or 400 mm spacing may be used when tank height will not permit the 600 mm dimension. (See Drawing No. SA4-015/50008)  
Only for 315 to 500 kVA transformers: Pressure relief valve on the tank cover, and oil filling plug on the tank cover.  
Only for 630 kVA to 2,000 kVA transformers: Pressure relief valve on the tank cover, oil conservator with dehydrating breather and oil level gauge. The cylinder of dehydrating breather shall be of transparent glass. The dehydrating breather shall be easy replaced and filled with silica-gel not less than 1.0 kg.
15. Only for 315 kVA to 2,000 kVA transformers: Transport rollers
16. Only for 1,000 kVA to 2,000 kVA transformers:
  - (a) Dial type thermometer with adjustable contact(s)
  - (b) Double float Buchholz relay having two (2) contacts (for alarm and tripping)
17. Other necessary accessories according to manufacturer's design.

#### 1c.15 Initial oil filling

The transformers shall be supplied with initial oil filling. The oil shall be according to IEC 60296, high-quality, clean and dry.

The oil shall be free from Polychlorinated biphenyls (PCB).

#### 1c.16 Nameplate

The following minimum nameplate information shall be legibly and durably inscribed on the metal part of nameplate:

- (1) Manufacturer's name
- (2) Manufacturer's serial number
- (3) Year of manufacture
- (4) PEA's code number





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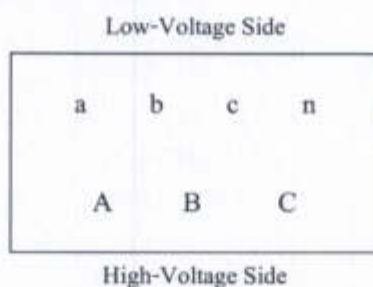
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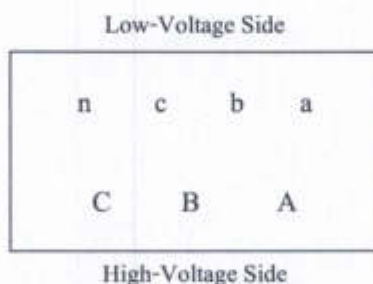
- (5) Contract number and/or PO number
- (6) Number of phases
- (7) Rated frequency in Hz
- (8) Rated power in kVA
- (9) Rated voltage in V
- (10) Rated current in A
- (11) Rated secondary short-circuit withstand current in kA r.m.s.
- (12) Tapping voltages in V
- (13) Connection symbol
- (14) Short-circuit impedance in %
- (15) Connection diagram
- (16) Type of cooling
- (17) Oil quantity in liters
- (18) Drain oil quantity in liters (for permanently sealed type)
- (19) Total weight in kg
- (20) Wording "**SHORT CIRCUIT WITHSTAND**"
- (21) Material of HV and LV winding such as copper winding, cooper foil etc.

#### 1c.17 Bushing location and terminal markings

Bushing shall locate as shown in the figures below:



**Figure 5 50-250 kVA Tank top view**



**Figure 6 315 -2,000 kVA Tank top view**



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The letters A, B, C, a, b, c, and n shall be durable marked on transformer tank beside bushings consequently. The height of the symbols shall not less than 30 mm.

Mark by sticker is not accepted.

**1c.18 Mass**

For 50 kVA to 160 kVA transformers: Mass of complete transformer with oil and accessories shall not be more than 1,000 kg.

For 250 kVA transformers: Mass of complete transformer with oil and accessories shall not be more than 1,200 kg.

Tolerance of the mass of proposed complete transformers with oil shall be within  $\pm 5$  percent of the declared mass of transformer which passed type test given by the bidders in 2a Performance data and guarantee of three-phase transformer (Page 28 of 32) but the maximum mass shall not exceed the above allowable mass.

If the mass of complete transformers with oil more than  $\pm 5$  percent of the declared mass or exceed the above allowable mass, the transformers shall be rejected.

**1d Packing**

For transformers manufactured outside the territories of Thailand, each transformer shall be seaworthy packed in individual export crate or wooden case which will not be returned.

For transformers manufactured within the territories of Thailand, each transformer shall be packed in individual crate or wooden case which will not be returned.

Only for 50 kVA to 160 kVA transformers for 22 kV systems and 50 kVA to 100 kVA transformers for 33 kV systems, each crate or wooden case shall be strong enough for stacking over with at least another one.

If the crate or wooden case is made of rubber wood (Yang-para), the wooden parts shall be treated with wood preservative.

The details of wood treatment shall be described.

**1e Tests and test reports**

**1e.1 Routine test**

Each transformer shall pass the manufacturer's standard routine tests, and also pass the following tests in accordance with the relevant standards:

- (1) Measurement of winding resistance (IEC 60076-1)
- (2) Measurement of voltage ratio and check of phase displacement (IEC 60076-1)
- (3) Measurement of short-circuit impedance and load loss (IEC 60076-1)
- (4) Measurement of no-load loss and current (IEC 60076-1)





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(5) Applied voltage test (IEC 60076-1 and IEC60076-3)

(6) Induced voltage withstand test (IEC 60076-1 and IEC60076-3)

**The Item offered without submitting the list of routine test report shall be rejected.**

**1e.2 Type test and Short-circuit withstand test**

For transformers rating of 50 kVA to 250 kVA and the reference transformers

For transformers rating of 50 kVA to 250 kVA and the reference transformers, these transformers shall be passed all items of type test and short circuit withstand test according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test**. The test result shall be included in one (1) test report. The test report shall be issued or approved by the same acknowledged independent testing laboratory according to **1e.3 Acknowledged independent testing laboratories**, otherwise will be rejected.

For the others rating which are not the reference transformers

The transformers shall be passed the following type tests in accordance with the relevant standards:

- (1) Temperature-rise test (IEC 60076-2)
- (2) Full wave lightning impulse test (IEC 60076-1 and IEC 60076-3)
- (3) Measurement of no-load loss and current at 90 % and 110 % of rated voltage (IEC 60076-1)

Type test shall be made on only one (1) unit of each rating. The test result shall be included in one (1) test report. The test report shall be issued or approved by the same acknowledged independent testing laboratory according to **1e.3 Acknowledged independent testing laboratories**, otherwise will be rejected.

**1e.2.1 Short-circuit withstand test**

The transformers shall be designed and constructed to withstand without damage by the thermal and dynamic effects of the external short circuit in accordance with the IEC 60076-5.

The duration of the current I to be used for the calculation of the thermal ability to withstand short circuit shall be 2 s and the initial temperature for calculation shall be 105°C.

Test procedure of short-circuit withstand test shall be according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test**.

The total number of tests shall be nine made in a different position of the tap-changer according to IEC 60076-5. The duration of each test shall be 0.5 s

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**1e.2.2 Test procedure of Type test and Short-circuit withstand test**

Each transformer, as delineated by its own unique serial number, is required to pass a complete type test and short-circuit withstand test following the procedures listed below:

- (1) Prior to short circuit testing, each individual transformer must pass the routine test, measurement of no-load loss and current at 90 % and 110 % of rated voltage and temperature-rise tests. Criteria for the temperature-rise test is presented in **1c.8 "Limits of temperature-rise"**
- (2) Upon successfully passing the temperature-rise test, each transformer must then successfully pass a short circuit withstand test
- (3) Finally, lightning impulse shall be tested and all the routine tests including measurement of no-load loss and current at 90 % and 110 % of rated voltage shall be repeated. Each transformer shall pass the routine test, measurement of no-load loss and current at 90 % and 110 % of rated voltage and lightning impulse test.

The impulse test sequence is applied to each of line terminal of the tested winding in succession. The other line terminals of the transformer shall be earthed directly or through an impedance.

If the laboratories intend to use PEA's power system as power supply for the short-circuit withstand testing, the transformer's manufacturer or the laboratories shall submit technical documents of the test such as test procedure, test circuit diagram, test and protection equipment, testing date and calculation of voltage drop in PEA's power system caused by the test to PEA for consideration and approval before the tests are proceeded.

It is responsible of the laboratories to compensate all failure or damage occurred to PEA's power system caused by the test.

PEA reserves the right to send representatives to witness the test.

**The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.**

**1e.2.3 Type test and short circuit test report**

For 50 to 250 kVA transformers, the bidders have to submit the type test and short circuit test report of the identical transformer (purchased transformer) with the bid, otherwise shall be rejected

For transformers which rated power more than 250 kVA, the bidders have to submit the following document with the bid, otherwise shall be rejected.

- (1) The type test report of the identical transformer (purchased transformer), and
- (2) The short circuit test report of identical transformer (purchased transformer) or the reference transformer according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test**, and
- (3) The calculation report<sup>(1)</sup> and others information according to **APPENDIX 1**.

**Note**

- <sup>(1)</sup> In case of the bidders submit the short circuit test report of the reference transformer, calculation report and others information shall be submitted.





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The type test and short-circuit withstand test report of the transformers which are conducted or inspected by Thailand's national laboratories/institutes shall be valid within five (5) years count from the issued date in the test reports to the bid closing date.

For the type test and short-circuit withstand test report of the transformers which are conducted or inspected by laboratories/institutes, with in other countries shall be valid within ten (10) years count from the issued date in the test reports to the bid closing date.

PEA will also accept other documents instead of the type test and short-circuit withstand test reports in the following conditions:

- (1) In case the proposed transformer has been supplied to PEA and get the order from PEA's Procurement Department or Substation Work Department or Transmission and Distribution System Work Department (from PEA's head office), the Purchase Order (PO) or Contract with List of suppliers or Proposal form can be submitted, or
- (2) In case the proposed transformer has been registered for PEA Product Acceptance, the not-expired registration certificate counted to the bid closing date can be submitted, or
- (3) In case the proposed transformer has been registered for Product lists for substation turnkey project, the not-expired registration certificate counted to the bid closing date can be submitted instead

However the document in case (1), (2) and (3) shall be proved that the transformer specified in the PO or Contract with List of suppliers or Proposal form or registration certificate shall be the same product, type/model and all ratings as the proposed transformer for this bid.

**The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.**

#### **1e.3 Acknowledged independent testing laboratories**

The type test and short-circuit withstand test shall be conducted or inspected by the acknowledged testing laboratories/institutes as follows:

- (1) Laboratories/institutes which are members of the Short-circuit Testing Liaison (STL) or independent laboratories/institutes which are accredited according to TIS 17025 or ISO/IEC 17025 with the scope of accreditation covered the relevant test items, standards and equipment. The certification and scope of accreditation of the independent laboratories/institutes shall be submitted with the bid for consideration.

The bidders or manufacturers who are accredited according to TIS 17025 or ISO/IEC 17025 preferring to carry out the type tests and short-circuit withstand test of the transformers with the laboratories or by the manufacturers themselves, the tests shall be inspected by Thailand's



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national laboratories, institutes, universities and electric utilities in (2) and other laboratories, institutes, universities or electric utilities approved by PEA.

- (2) Thailand's national laboratories, institutes, universities and electric utilities, as follow:
  - Electricity Generating Authority of Thailand (EGAT)
- (3) Other laboratories, institutes, universities or electric utilities approved by PEA. In this case, the detail of the test facilities of the laboratories shall be submitted to PEA for approval before proceeding the tests and before the bid closing date. PEA reserves the right to send representatives to inspect and witness the tests with the cost of the bidders or manufacturers.

**1e.4 The information in the Test report**

The minimum information of the transformer in the type test and short-circuit withstand test report shall be the following items:

**1. Transformer information**

- (1) Manufacturer's name
- (2) Model
- (3) Manufacturer's serial number
- (4) Number of phase
- (5) Rated voltage of the high-voltage winding
- (6) Rated voltage of the low-voltage winding
- (7) Rated voltage ratio
- (8) Rated frequency
- (9) Rated power
- (10) Rated current of the high-voltage winding
- (11) Rated current of the low-voltage winding
- (12) Short-circuit impedance at 75°C
- (13) Connection symbol
- (14) Cooling method
- (15) Total mass
- (16) Mass of core and winding
- (17) Oil quantity
- (18) Highest voltage for equipment applicable the high-voltage winding
- (19) Highest voltage for equipment applicable the low-voltage winding
- (20) Rated insulation level
- (21) Type of construction
- (22) High-voltage winding type and material





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- (23) Low-voltage winding type and material
- (24) Cross-section of the conductor in the high-voltage winding
- (25) Cross-section of the conductor in the low-voltage winding
- (26) Number of strands per turn of high voltage winding
- (27) Number of strands per turn of low voltage winding
- (28) Number of strands radially across the layer (for all turns) of high voltage winding
- (29) Number of strands radially across the layer (for all turns) of low voltage winding
- (30) Total number of turns per phase
- (31) Number of turns each tap

## 2. Drawing

- (1) Overall dimensions of transformer
- (2) Tank dimension
- (3) Drawing of cross section area of core
- (4) Drawing of active part
- (5) Drawing which show the core and coil information according to **Figure 7**

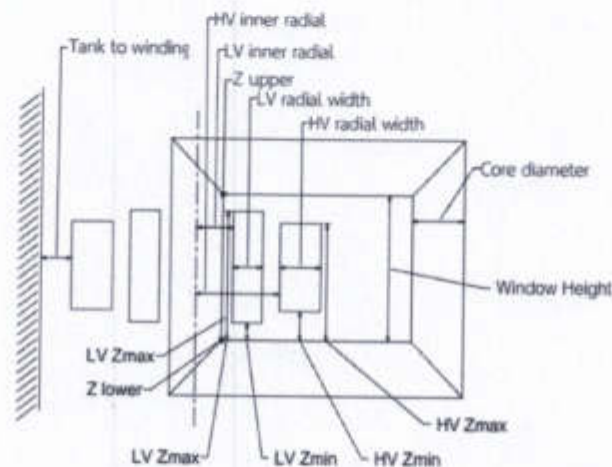


Figure 7: Core and coil constructions.

## 3. Photograph of transformers

The color photograph which reveal transformer construction for out-of-tank inspection before and after short-circuit withstand test shall be in the short-circuit withstand test report.

In case the information in the reports are not completed according to the above requirement, the bidders will be rejected.