



PROVINCIAL ELECTRICITY AUTHORITY

TECHNICAL SPECIFICATION DIVISION

**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 Page 28 of 32

Item

| | | |
|--|--------------------|--|
| - Full-wave impulse withstand voltage, or BIL | kV, peak | |
| - Power-frequency test voltage, 1 min | kV, r.m.s. | |
| - Construction of winding | - | |
| - Current density | A/mm ² | |
| - Number of layer per coil | - | |
| - Number of turns of each coil in tap No.3 | Turns | |
| - Number of turns of each tapping position | Turns | |
| - Total turns of each coil | Turns | |
| Core | | |
| - Manufacturer's name (the bidders have to quote not more than three (3) manufacturers) | - | |
| - Country of origin | - | |
| Pressure relief valve | | |
| - Manufacturer's name | - | |
| - Country of origin | - | |
| - Type or model | - | |
| - Operating pressure | kg/cm ² | |
| - Flow rate at..... kg/cm ² | cc/sec | |
| Method of cooling | - | |
| Total cooling surface | m ² | |
| Brand of oil used for initial filling | - | |
| Completely assembled transformer shall withstand, without permanent deformation, a maximum pressure of | kg/cm ² | |
| Colour of tank: grey (RAL 7036) | Yes/No | |
| Tank finish conforms to PEA's requirement | Yes/No | |
| Quantity of oil filling | liters | |
| Mass of core | kg | |
| Mass of winding | kg | |
| Mass of the part liftable from tank | kg | |
| Mass of complete transformer with oil | kg | |
| Terminal markings and connections conform to PEA's requirement | Yes/No | |



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| | | |
|---|--------|--|
| Tank | | |
| - Thickness of side wall | mm | |
| - Thickness of top plate | mm | |
| - Thickness of bottom plate | mm | |
| Internal dimensions | | |
| - Height | mm | |
| - Width | mm | |
| - Depth | mm | |
| Dimensions of transformer | | |
| Overall height | mm | |
| Overall width | mm | |
| Overall depth | mm | |
| Height over cover | mm | |
| Total dry film thickness | µm | |
| Fin | | |
| - Fin radiators or Corrugated thickness | mm | |
| - Dimension of each fin (LxBxT) | mm | |
| Number of Fins per radiator | | |
| - Side of tank | - | |
| - Front of tank | - | |
| - Total number of fin | - | |
| Bushing clearance | | |
| Please fill in the shortest of clearance | mm | |
| LV to earth | mm | |
| HV to earth | mm | |
| Between LV bushing | mm | |
| Between HV bushing | mm | |
| Detail documents of Item 1 on Page 31 to 32 of 32 shall be sent to PEA before shipment/delivery | Yes/No | |



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| | | |
|--|---------|--|
| X/R ratio | - | |
| Rated short circuit current and withstanding duration | | |
| - Current | kA | |
| - Duration | s | |
| Duration of overload | | |
| - 25% overload | Minutes | |
| - 50% overload | Minutes | |
| Magnetic flux density | Tesla | |
| Other : | | |



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Note: Conditions for documentation and consideration

1. The Contractor has to supply the following documents in English and/or Thai before shipment/delivery, for each ordered transformer:
 - 1.1 Report of routine tests
 - 1.2 Number of turns of each winding, each coil, and each tapping position
 - 1.3 Mass of HV windings and of LV windings
 - 1.4 Type of enamel, temperature class, and size of the enameled wire
 - 1.5 Information for Reference (only one(1) unit per contract). The following information for each transformer shall be submitted for maintenance purpose.
 - Coil height for each winding before assembly and after complete assembly.
 - Torque value on clamping bolts or pressure for each winding before assembly and after complete assembly.
 - Photograph of each coil for each phase and photograph of core and coils assembly. The photograph of each coil shall be taken from the final production process before placing to the core, top view and front view shall be provided. The photograph of core and coils assembly shall be taken just prior to place the completed core and coils assembly into the tank, top view, front view, right view, left view and rear view shall be provided for complete set of photographs. All photographs shall be 216 mm (8-1/2 in) by 280 mm (11 in) gloss prints properly labeled relevant to the view taken.
 - 1.6 Invoice and Test report of the following material and accessories used in each supply shall be submitted.
 - Transformer oil
 - Silicon steel
 - Copper conductor
 - Insulation paper and pressboard
 - Pressure relief
 - Gaskets
 - Bushing
 - Transformer supervisory equipment



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The above documents shall be sent to the following address:

Transformer Division
Provincial Electricity Authority
200 Ngam Wong Wan Road, Chatuchak
Bangkok Metropolis 10900
Thailand

2. If the material and packing data given by bidders, which are mentioned on Pages 23 to 24 of 32 are estimated or approximated, the bid may be rejected.
3. Delivery time is also one of the important factors to be considered.
4. Partial shipment/delivery is allowed.



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

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APPENDIX 1

Comparison Method

In case the ability to withstand the dynamic short circuit is demonstrated by comparison between the reference transformer and similar transformer. In this case the bidders have to submit the short circuit test report of the reference transformer, calculation report of short circuit force which using Finite Element Method (FEM) software, all necessary information according to **Table 3** Design data of the reference transformers and the proposed transformers as well as the necessary information in order to show that the short-circuit withstand test report can prove the performance of the proposed transformers with the bid.

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

For the ability to withstand the dynamic effects of short circuit test, the total number of tests shall be three made in a different position of the tap-changer according to IEC 60076-5. The duration of each test shall be 0.5 s

The transformer is considered similar or representative to another transformer (proposed transformers) taken as a reference if it has the following characteristics in common with the latter:

- (1) Same type of operation, for example generator step-up unit, distribution, interconnection transformer and same rated voltage according to **Table 1**;
- (2) Same conceptual design, for example dry-type, oil-immersed type, core type with concentric windings, sandwich type, shell type, circular coils, non-circular coils;
- (3) Same arrangement and geometrical sequence of the main windings;
- (4) Same type of winding conductors, for example, aluminium, aluminium alloy, annealed or hardened copper, metal foil, wire, flat conductor, continuously transposed conductors and epoxy bonding, if used;
- (5) Same type of main windings for example, helical-, disc-, layer-type, pancake coils;
- (6) Absorbed power at short circuit (rated power/per unit short-circuit impedance) between 30% and 130% of that relating to the reference unit, see **Table 2**;
- (7) Axial forces, radial forces, axial winding stresses and radial winding stresses occurring at short circuit not exceeding 120% of those in the reference unit. (Force shall be calculated by Finite element program such as FLD12 etc., Hand calculation shall be rejected)
- (8) Same manufacturing processes;
- (9) Same clamping and winding support arrangement.

In case the comparison method, the short-circuit withstand test report of the reference transformer and a calculation report as a result of the comparison between the reference transformer and proposed transformer shall be submitted with the bid. The calculation report shall give evidence the force and stress according to item (7) and all necessary information according to item (1) to (9).





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Table 1

Type of operation and rated voltage of the proposed transformers similar to the reference transformers

| Type and Rated voltage | The reference transformer | The proposed transformers |
|-----------------------------------|---------------------------|---------------------------|
| Type | 3 Phase only | 3 Phase |
| Rated primary voltage | 22 kV | 22 kV |
| Rated primary voltage | 33 kV | 33 kV |
| Rated secondary voltage (3 phase) | 416/240 V | 416/240 V |

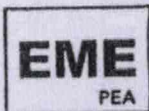
Table 2

Rated power of the proposed transformers similar to the reference transformers

| | Rated power (kVA) of the reference transformers | Rated power (kVA) of the proposed transformers | | | | | | | | |
|----|---|--|-----|--------------------|-----|-----|-------|-------|-------|-------|
| | | 315 | 400 | 500 ⁽¹⁾ | 630 | 800 | 1,000 | 1,250 | 1,500 | 2,000 |
| 1 | 250 | 315 | | 500 ⁽¹⁾ | | | | | | |
| 2 | 315 | 315 | 400 | 500 ⁽¹⁾ | | | | | | |
| 3 | 400 | 315 | 400 | 500 ⁽¹⁾ | 630 | | | | | |
| 4 | 500 ⁽¹⁾ | 315 | 400 | 500 ⁽¹⁾ | | | | | | |
| 5 | 630 | 315 | 400 | 500 ⁽¹⁾ | 630 | 800 | | | | |
| 6 | 800 | 315 | 400 | 500 ⁽¹⁾ | 630 | 800 | 1,000 | | | |
| 7 | 1,000 | 315 | 400 | 500 ⁽¹⁾ | 630 | 800 | 1,000 | 1,250 | | |
| 8 | 1,250 | 315 | 400 | 500 ⁽¹⁾ | 630 | 800 | 1,000 | 1,250 | 1,500 | |
| 9 | 1,500 | 315 | 400 | 500 ⁽¹⁾ | 630 | 800 | 1,000 | 1,250 | 1,500 | |
| 10 | 2,000 | | 400 | | 630 | 800 | 1,000 | 1,250 | 1,500 | 2,000 |

Note :

⁽¹⁾ Based on 6.5% short-circuit impedance. In case the impedance of 500 kVA transformer more than 6.5%, the bidders shall recalculate this table for PEA approval.





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Table 3

Design data of the reference transformers and the proposed transformers

| Description | Design value of the reference transformers | | Design value of the proposed transformers | |
|--|--|-----------|---|-----------|
| | | | | |
| Rating (kVA) | | | | |
| % Short circuit impedance | | | | |
| Construction of Core | | | | |
| HV Windings, made of | | | | |
| LV Windings, made of | | | | |
| Construction of HV Windings (Layer or disk) | | | | |
| Construction of LV Windings (Layer or Foil) | | | | |
| HV Current density (please enclosed the calculation sheet) | | | | |
| LV Current density (please enclosed the calculation sheet) | | | | |
| Axial force (please enclosed software calculation sheet) | <u>HV</u> | <u>LV</u> | <u>HV</u> | <u>LV</u> |
| Axial stress (please enclosed software calculation sheet) | <u>HV</u> | <u>LV</u> | <u>HV</u> | <u>LV</u> |
| Radial force (please enclosed software calculation sheet) | <u>HV</u> | <u>LV</u> | <u>HV</u> | <u>LV</u> |
| Radial stress (please enclosed software calculation sheet) | <u>HV</u> | <u>LV</u> | <u>HV</u> | <u>LV</u> |
| Same arrangement of main windings and geometrical sequence as the reference unit (Yes/No) (please enclosed the winding detail drawing) | | | | |
| Same clamping and supporting arrangement. (Yes/No) (please enclosed the clamping detail drawing) | | | | |

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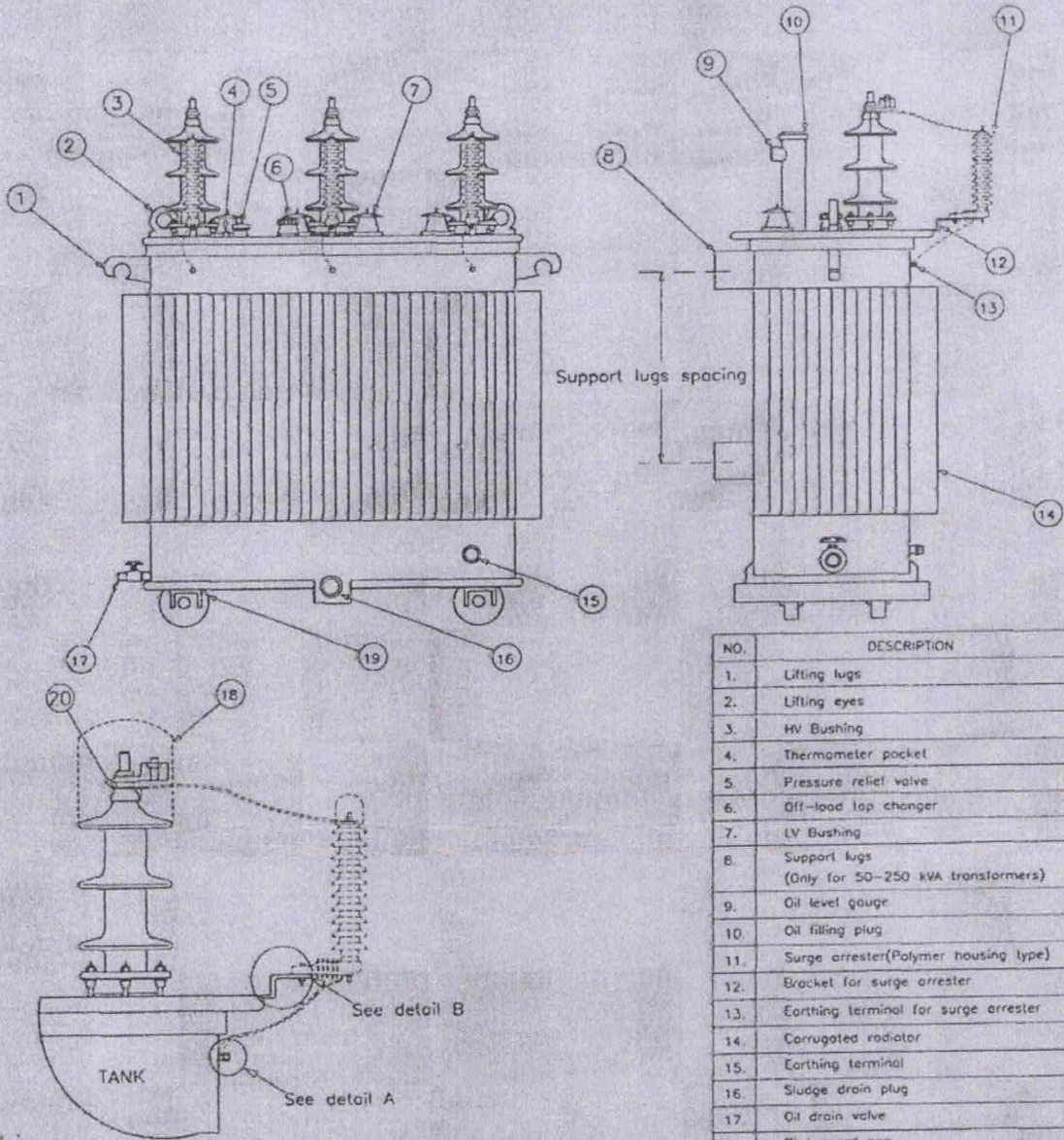
C3 Schedule of detailed requirement

Invitation to Bid No.: N2.EB.STK.(๓๗.)-15-2566

| Item | PEA Material No. | Quantity | Description |
|------|------------------|-----------|--|
| (2) | 1050010066 | 33 set(s) | 50 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |
| (3) | 1050010067 | 30 set(s) | 100 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |
| (4) | 1050010068 | 11 set(s) | 160 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |
| (5) | 1050010069 | 12 set(s) | 250 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |
| (6) | 1050010070 | 1 set(s) | 315 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |
| (7) | 1050010071 | 1 set(s) | 400 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |
| (8) | 1050010072 | 1 set(s) | 500 kVA, three-phase transformer, permanently sealed and completely oil filled system (without gas cushion) type, withstand short-circuit, 22,000-416/240V, symbol Dyn11 |

Only for 50-500 kVA transformers

PRELIMINARY



| NO. | DESCRIPTION |
|-----|--|
| 1. | Lifting lugs |
| 2. | Lifting eyes |
| 3. | HV Bushing |
| 4. | Thermometer pocket |
| 5. | Pressure relief valve |
| 6. | Off-load tap changer |
| 7. | LV Bushing |
| 8. | Support lugs (Only for 50-250 kVA transformers) |
| 9. | Oil level gauge |
| 10. | Oil filling plug |
| 11. | Surge arrester(Polymer housing type) |
| 12. | Bracket for surge arrester |
| 13. | Earthing terminal for surge arrester |
| 14. | Corrugated radiator |
| 15. | Earthing terminal |
| 16. | Sludge drain plug |
| 17. | Oil drain valve |
| 18. | Bird guard cap |
| 19. | Transport rollers (Only for 315-500 kVA transformers) |
| 20. | Cable lug |

Note :

1. Surge arrester, line lead and ground lead, supplied by PEA
2. Earthing terminal for surge arrester shall be eye-bolt type or socket type.
3. Position of earthing terminal for surge arrester shall be suitable for flexible copper insulated ground lead size 16 sq.mm, 430 mm long.
4. Not to scale

| | | |
|--|--|---|
| กองมาตรฐานระบบไฟฟ้า ฝ่ายมาตรฐานและความปลอดภัย | การไฟฟ้าส่วนภูมิภาค | ใช้แทนแบบ..... ถูกแทนโดยแบบ..... เขียนเสร็จวันที่ 8 มี.ย. 2552 แก่แบบวันที่ 26 พ.ค. 2554 มีมติเป็น..... มาตรฐาน..... แบบเลขที่ SA4-015/50008 แผ่นที่ 1. ของจำนวน 4. แผ่น |
| ผู้เขียน... นิตเชิด เพ็ญดา... ผู้สำรวจ..... วิศวกร..... หัวหน้าแผนก..... ผู้อำนวยการกอง..... ผู้อำนวยการฝ่าย..... | ส่วนประกอบหม้อแปลงไฟฟ้า 3 เฟส DETAIL OF 3 PHASE TRANSFORMER | |