

March 2020

SPECIFICATION SS-112/5
150kV INDUCTIVE TYPE OUTDOOR VOLTAGE
TRANSFORMERS

I. SCOPE

This hereby technical description covers IPTO requirements regarding design features, technical characteristics and testing of single – phase, outdoor, inductive type 150kV voltage transformers.

II. KEY WORDS

Voltage transformers, instrument transformers, measurement transformers.

III. STANDARDS

The voltage transformers shall conform to the latest edition of IEC 61869-1 and 61869-3 standards.

IV. USE

The voltage transformers will be used for bays of 150 / 20kV air insulated substations.

V. OPERATING CONDITIONS

- | | |
|----------------------------------|------------------------------------|
| 1. Installation | : Outdoors |
| 2. Limits of ambient temperature | : Maximum +45 °C
Minimum -25 °C |
| 3. Altitude | : Up to 1000m above
Sea level. |
| 4. Pollution level | : Moderate |
| 5. Other climatic conditions | : Snow. Ice and fog |

VI. IPTO's 150KV ELECTRIC SYSTEM CHARACTERISTICS

- | | |
|---|---------------------------------------|
| 1. Nominal Voltage (phase to phase) | : 150kV |
| 2. Maximum Operating Voltage (phase to phase) | : 170kV |
| 3. Nominal frequency | : 50HZ |
| 4. Short Circuit level | : 31.5 kA |
| 5. Basic Insulation level (Lightning Impulse) | : 750kV |
| 6. Number of phases and conductors | : 3-phase, 3-conductors, |
| 7. Earthing (grounding) Method | : The neutral is solidly
grounded. |

VII. REQUIRED DESIGN FEATURES OF THE VOLTAGE TRANSFORMERS

1. Type of voltage transformer

Outdoor, single – phase, oil immersed inductive voltage transformers with one primary winding and three (3) separate secondary windings.

2. Required Electrical diagram of 150KV voltage transformers

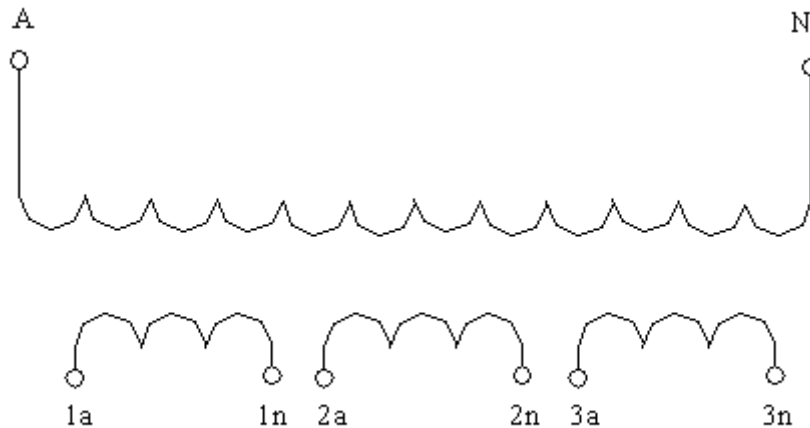


Fig. No.1

3. Ratio

As indicated in the attachment “A”.

4. Secondary Windings

The VTs will be equipped with three (3) secondary windings as shown in Fig. No 1. Two of these windings will be used for metering purposes, and one for protection purpose. The output power, accuracy class, limits of the voltage error and phase displacement of the secondaries shall be as indicated in attachment “A”.

5. Primary winding

The primary winding shall be as indicated in Fig.No. 1 with the rating voltage as specified in attachment “A”.

6. Connection of the primary winding.

Phase – to – earth (single – pole)

7. Housing (enclosure) of the VTs

The housing which serves as insulator shall be of silicon rubber. The silicon rubber housing shall be in accordance with IEC 61462 “Composite insulators – Hollow insulators for use in outdoor and indoor electrical equipment”.

8. Creepage distance of the Housing

The creepage distance of the housing shall be ≥ 4250 mm.

9. Insulating Oil

Only mineral oil shall be used and which must be non-toxic. The insulating oil shall be in accordance with the latest version of IEC 60296, for transformer oil. The use of toxic insulating agents such as PCBs or PCT's etc is prohibited.

10. Oil – expansion bellows and sealing

The VT interior shall be filled with insulating oil and the VT shall be hermetically sealed against humidity.

Any oil volume changes due to temperature fluctuations shall be accommodate by appropriate expansion of the bellows (metallic bellows are preferred) located on the VT head.

The sealing of the transformer shall be ensued by welding (welded type transformer), or through suitable sealing ring (O-RING) with proven long life and resistance to insulating oil, ultraviolet radiation and temperature within the limits of par. V.

11. Primary Terminals

The primary terminals shall be of nickel plate copper, cylindrical in shape with diameter of 30mm and length of about 100mm, located preferably at the center of the VT' s head.

12. Secondary terminals box

For the secondary terminals' box, it should be anticipated the existence of two (2) separated compartments of the terminal box, one for the secondary metering circuits and one for the secondary protection circuit so that they can be sealed separately. The compartments will be situated on the same side of the Voltage Transformer and there will be a cover with suitable hinges to be closed without any special tool, with one or two screws, suitable for the security of the box.

The terminals shall consist of threaded stubs fitted with nuts and washers. The bottom plate of the secondary terminals' box shall be furnished without holes but it has to be easily drilled. Moreover, the bottom plate of it shall be sufficiently large to bear three (3) cable glands suitable for a cable of 4x4mm², Ø21mm. The terminals shall be easily accessible and shall be suitable to be wired with conductors of 4mm². All secondary phase leads shall be protected by 6A fuses and the neutral leads by links. It shall be possible to short circuit one of these fuse elements easily in the terminal compartment. It shall be possible to connect the neutral sides of all secondary windings to the ground easily. For this purpose, one grounding screw shall be available in the compartment.

The secondary winding terminals shall be located in a weatherproof hot-dip galvanized box, made either of steel or a different kind of non-corrosive metal, which will be mounted on the metallic base of the VT. The terminal box shall have protection degree IP55.

13. Metal frame (case) parts

Apart from the primary terminals all other frame metal parts shall either be of hot – dip galvanised steel or of non – corrosive metal.

14. Installation

The VT shall be suitable for installation on an outdoor steel support structure.

15. Location of the active VT system

The active VT system consisting of the primary and secondary windings with cores shall be located in a tank, at the VT base (“dead tank” type). VTs, which do not have the active system at their base, can be accepted, provided that they follow the requirements of par.VII-16.

16. Seismic requirements

- a. Seismic qualification of the VT’s shall be in accordance with the IEC-61463 and IEC-60068-3-3
- b. The VT’s shall be capable of withstanding the following seismic stresses:
 1. Horizontally (axes x and y) : 0,5g (5m/s^2)
 2. Vertically (axe z) : 0,25g ($2,5\text{m/s}^2$)
- c. Both directions to be assumed to reach their maximum values simultaneously.
- d. The frequency range should be 1 Hz to 35Hz.
- e. Acceptable methods of seismic qualification are:
 1. Qualification by vibration test or
 2. Qualification by static calculation or
 3. Qualification by dynamic analysis
- f. Bidders are obliged to submit in their offers, test reports or calculation by dynamic analysis, or static calculation.
Approval or not of all of the above, lies on IPTO’s judgment.

17. Accessories

Each VT shall be equipped with the following:

- Oil level indicator
- Oil – filling plug
- Oil – drain plug
- Lifting lugs
- A special terminal for measuring $\tan\delta$ which shall be short – circuited during normal operation.

18. Spill Gaps

Each voltage transformer must be equipped with spill gaps, which should be adjusted as below:

Spill gap adjustment (mm)	
From	To
625	875

19. Weight of the V.T

The total weight of the V.T including the oil shall not exceed 800kg

20. Height of the VT

The total height of the VT shall not exceed 2.700mm

VIII. REQUIRED RATING CHARACTERISTICS OF THE VTs

1. Rated frequency	: 50Hz
2. Ratio	: $\frac{160000}{\sqrt{3}}$ V / $\frac{120}{\sqrt{3}}, \frac{120}{\sqrt{3}}, \frac{120}{\sqrt{3}}$ V
3. Number of Secondary Windings.	: 3
4. Minimum length of creepage path	: 4250mm
5. Partial discharge level	: ≤ 5pC at 118kV
6. Power frequency withstand voltage for the secondary windings	: 3kV (r.m.s.)
7. Rated lightning impulse withstand voltage for the phase (pole) of the primary terminal	: 750kV (peak)
8. Chopped lightning impulse withstand	: 863kV (peak)
9. Power frequency withstand voltage of the primary neutral (earthed) terminal	: 3kV (r.m.s.)
10. Rated power – frequency withstand voltage of the phase (pole) of the primary terminal.	: 325kV (r.m.s.)
11. Limits of the temperature rise of the windings.	: 65⁰K
12. Temperature category.	: -25 / +45⁰C
13. Dielectric dissipation factor (tanδ).	: ≤ 0.005 at 10 kV - 98 kV
14. Static loading withstand	: 1000N
15. Rated voltage factors	: 1.2 continuous 1.5 for 30 seconds
16. Transmitted overvoltage limit	: ≤ 1.6 kV (peak) at pulse of 222kV (peak)
17. Radio interference voltage limit.	: $\leq 2500\mu$V at 108 kV

IX. TESTS

All testing shall be in accordance with IEC 61869-1 and 61869-3 standards:

i. Type tests

1. Temperature rise test.
 2. Short – circuit withstand capability test.
 3. Lightning impulse test
 4. Power frequency voltage wet test for outdoor type voltage transformers
 5. Radio interference voltage test
 6. Verification of IP degree of protection for the terminal box
- ii. Routine tests
1. Verification of terminal markings
 2. Power – frequency withstand tests on primary winding.
 3. Partial discharge measurement
 4. Power – frequency withstand test on secondary windings .
 5. Accuracy tests (will be executed last)
- iii. Special Tests (on one VT of the order)
1. Chopped impulse test on primary winding
 2. Measurement of capacitance and dielectric dissipation factor
 3. Transmitted overvoltage test
 4. Mechanical tests
 5. Accuracy tests (repetition of type tests for every secondary winding)
 6. Enclosure tightness test

The enclosure tightness test shall be performed with a pressure of the oil at least 1 bar higher than the maximum operating pressure during normal service conditions and at a temperature of 80°C for 8 hours.

Alternatively, an equivalent enclosure tightness test can be performed, subjected to IPTO's approval, provided that the test procedure will be submitted with the bid.

X. MARKINGS

a. Terminal markings

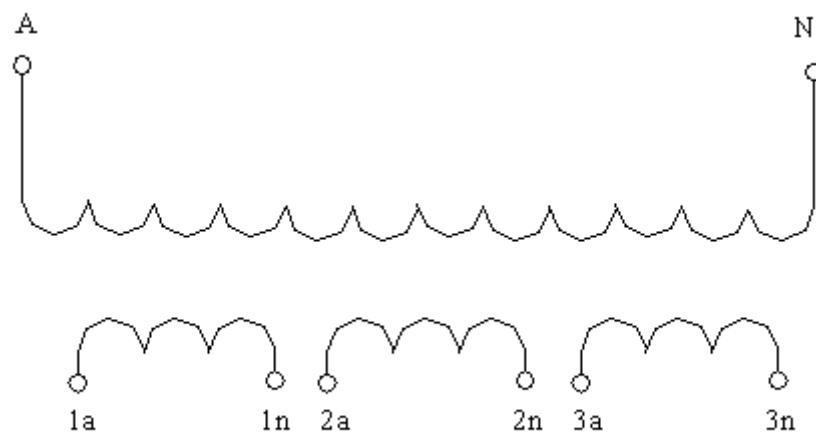


Fig. No.2

b. Rating plate markings

All VT's shall bear a rating plate of non – corrosive material with the following markings:

1. The manufacture's name.
2. Serial number and type.
3. Rated primary and secondary voltage.
4. Rated frequency.
5. The rated insulation level
6. Rated output and corresponding accuracy class of secondary windings.
7. Highest voltage.
8. Rated voltage factor and corresponding rated time.

XI. DATA TO BE SUBMITTED BY BIDDERS

1. Bidders shall supply all the technical data requested in attachment "B", attached hereto, as well as any proposed departures from the present specification and the reason therefore. Failure on bidder's part to comply with this request will be taken as sufficient reason for rejection of the offer.
2. Technical pamphlets and brochures of the offered voltage transformers, which will help the technical evaluation process.
3. Technical data for the oil used in the voltage transformers.
4. Outline drawings showing overall dimensions of the VT, drawing indicating terminal markings as well as any information, sketches and data necessary for a complete description of the proposed voltage transformers.
5. Any type test certificates for the type and special tests specified in this hereby specification.
Acceptance or not of these certificates lies on the judgment of IPTO.

XII. DATA TO BE SUPPLIED BY THE SUCCESSFUL BIDDER

After the signing of the contract, the successful bidder shall furnish three (3) sets of drawings for approval prior to the VTs construction. The drawing shall include outline dimensional drawing, detail base drawing, wiring and terminal marking drawings. The outline drawing shall include all necessary information, which will enable IPTO to construct the VT's support steel structure.

XIII. PACKING

The transformers shall be delivered in entirely closed and robust wooden boxes of at least 20mm thickness. The boxes will be of "pallet type", with strengthened base.

Each wooden box will include one (1) transformer and all necessary assembling material (if applicable).

XIV. WARRANTY

The Supplier must provide a warranty for “good operation” of three four (4) years beginning from the date of delivery of the VTs.

«ATTACHMENT A»

**150kV INDUCTIVE TYPE OUTDOOR VOLTAGE
TRANSFORMERS (VT's)**

1. Ratio : $\frac{160000}{\sqrt{3}} \text{ V} / \frac{120}{\sqrt{3}}, \frac{120}{\sqrt{3}}, \frac{120}{\sqrt{3}} \text{ V}$
2. Primary voltage : $\frac{160000}{\sqrt{3}} \text{ V}$
3. Secondary voltage : $\frac{120}{\sqrt{3}} \text{ V}$
4. Accuracy class, rated output, percentage voltage error and phase displacement of the secondary windings
 - a. For the winding used for metering purpose (1a – 1n)
 - Number of windings : 1
 - Rated output : 25 VA
 - Accuracy class : 0.2
 - Percentage voltage error : ± 0.2
 - Phase displacements : ± 10 minutes
 - b. For the winding used for metering purpose (2a – 2n)
 - Number of windings : 1
 - Rated output : 50 VA
 - Accuracy class : 0.2
 - Percentage voltage error : ± 0.2
 - Phase displacements : ± 10 minutes
 - c. For protection purpose (3a – 3n)
 - Number of windings : 1
 - Rated output : 10 VA
 - Accuracy class : 3P
 - Percentage voltage error : ± 3.0
 - Phase displacements : ± 120 minutes

The accuracy of each winding is valid with simultaneous burden of all other windings between 0% – 100%.

«ATTACHMENT B»

**150kV INDUCTIVE TYPE OUTDOOR VOLTAGE
TRANSFORMERS (VT's)**

Data to be provided by all bidders. Failure to comply will constitute reason for rejection of the offer.

1. Type and manufacture :
2. Ratio :
3. Connection of primary winding :
4. Rated frequency :
5. Number of secondary windings :
6. Rated output and accuracy class of the
secondary winding for the metering
purpose 1a-1n :
.....
7. Rated output and accuracy class of the
secondary winding for metering
purpose 2a-2n :
.....
8. Rated output, accuracy class and
accuracy limit factor of the secondary
winding for protection purpose 3a-3n. :
.....
.....
.....
9. Temperature category :
10. Rated voltage factors
-Continuous :
.....
-1.5 for 30 seconds :

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- 11.** Limit of temperature rise of windings :
- 12.** Limits of voltage (ratio) error and
phase displacement :
- a. For the metering
purpose winding 1a -1n
1. Percentage voltage (ratio) error :
2. Phase displacement :
- b. For the metering purpose winding 2a -2n
1. Percentage voltage (ratio) error :
2. Phase displacement :
- c. For the protection purpose winding
1. Percentage voltage (ratio) error :
2. Phase displacement :
- 13.** Power frequency voltage withstand of
the phase primary winding. :
- 14.** Lightning impulse voltage withstand of
the phase primary winding :
- 15.** Power frequency withstand voltage for
the earthed primary terminal :
- 16.** Power frequency withstand voltage for
the secondary windings :
- 17.** Partial discharges permissible level
- 18.** Type of Housing :
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- 19.** Creepage distance of the housing :
- 20.** Type of oil-expansion bellows and sealing :
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- 20a.** Is the sealing of the transformer ensured by
welding (welded type transformer)
or through "O-RING"? :
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- 21. Description of the primary terminals** :
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- 22. Description of the terminal box
of the secondaries** :
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-
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- 23. Description of the metal frame (case)
parts** :
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-
-
- 24. Location of the active system of the VT** :
- 25. If active part is not located at the base
of the VT, is seismic test certificates
or seismic study provided?** :
- 26. Description of oil (if applicable)** :
-
-
-
- 27. Description of accessories (if applicable)** :
-
-
-
- 28. Total weight of the VT** :
- 29. Are the terminals in the box of the
secondaries of the screw type and suitable
to be wired with 4mm² size conductors?** :
- 30. Chopped lighting impulse withstand
voltage** :

31. Total height of the VT :
32. Weight of oil :
33. Radio interference voltage :
34. Transmitted overvoltage limit :
35. Dielectric dissipation factor :
36. Static loading withstand :
37. Are the phase and neutral secondary
leads protected by 6A fuses and links
respectively? :
38. Where are the above fuses and links
installed? :
39. Is the housing of silicon rubber? :
40. Is the voltage transformer equipped
with adjustable spill gaps between
25" and 35" (inches)? :
41. Does the Supplier provide a warranty
according to paragr. XIV? :
42. Will the package of the transformers follow the
requirements of par. XIII of this hereby specification?:
43. Are two separate compartments anticipated
in the secondary terminal box? :