

March 2020

SPECIFICATION SS – 56/4

150kV CURRENT TRANSFORMERS

I. SCOPE

This hereby technical description covers IPTO's requirements regarding design features, technical characteristics and testing of single-phase, oil-immersed, outdoor, 150kV current transformers.

II. KEY WORDS

Current transformers, instrument transformers.

III. STANDARDS

The current transformers shall conform to the latest edition of IEC 61869-1 and 61869-2 standards.

IV. USE

The current transformers will be used in 150kV bays of air insulated substations or extra high voltage 400/150/30kV substations.

V. OPERATING CONDITIONS

- | | |
|----------------------------------|--------------------------------|
| 1. Installation | : Outdoors |
| 2. Limits of ambient temperature | : -25°C to + 45°C |
| 3. Altitude | : Up to 1000 m 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 | : 31,5kA |
| 5. Basic Insulation level | : 750kV |
| 6. The Earthing (grounding) Method | : The neutral is solidly |
| 7. Number of phases and wires | : 3-phase – 3-wire system |

VII. REQUIRED DESIGN FEATURES OF THE CURRENT TRANSFORMERS

1. Type of CT

Outdoor, single-phase, oil immersed current transformers with one primary winding with two sections and five (5) secondary windings, each with its own magnetic core as shown in Fig. No 1 below:

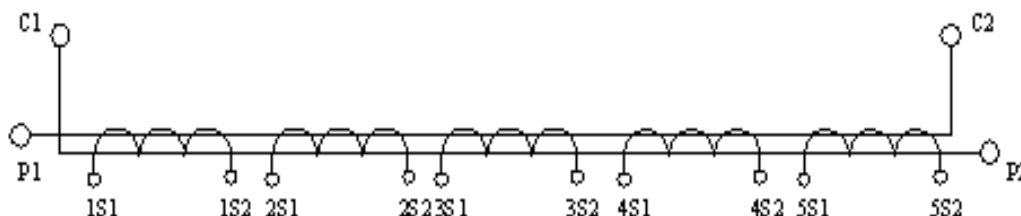


Fig. No. 1

2. Ratio

As indicated in the attachment A.

3. Secondary Windings

The CTs will be equipped with five (5) secondary windings as shown in Fig. No 1. Two (2) of these windings will be used for metering purposes and three (3) for protection purposes. The output power and the accuracy class of the secondaries shall be as indicated in attachment "A".

4. Primary winding

The primary winding shall consist of two sections as indicated in Fig No. 1 with the rating current as indicated in attachment "A".

5. Housing (enclosure) of the CTs

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".

6. Creepage distance of the Housing

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

7. 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.

8. Oil-expansion bellows and sealing

The CT interior shall be filled with insulating oil and the CT 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 CT head.

The sealing of the transformer shall be ensured 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.

9. Primary Terminals

The primary terminals shall be of copper, cylindrical in shape with a 30 mm in diameter and with a minimum of 80 mm in length. These terminals shall be placed horizontally and diametrically opposite on the CT head.

10. 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 CT and preferably in parallel to the axis of the H.V. terminals (under P1). 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 has to be easily drilled. Moreover, the bottom plate of it shall be sufficiently large to bear four (4) 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. 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.

11. Metal frame (case) parts

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

12. Installation

The CT shall be suitable for installation on a steel structure.

13. Location of the active CT system

The active CT system consisting of the primary and secondary windings with cores shall be located in a tank, at the CT base ("dead tank" type). CTs, which do not have the active system at their base, can be accepted, if they are in accordance with the requirements of paragraph VII – 14.

14. Requirements of seismic qualification

a. Seismic qualification of the CTs shall be in accordance with the IEC-61463 and IEC-60068-3-3

b. The CTs shall be withstood the following seismic stresses:

1. Horizontally (axes x and y) : 0,5g (5m/s²)
2. Vertically (z axis) : 0,25g (2,5m/s²)

c. The frequency range should be 1 Hz to 35Hz.

d. Acceptable methods of seismic qualification are:

1. Qualification by vibration test or
2. Qualification by static calculation or
3. Qualification by dynamic analysis

e. Bidders are obliged to submit in their offers, test reports or calculation by dynamic analysis, or static calculation.

Approval or not of all the above lies on IPTO's judgment.

15. Accessories

Each CT shall be equipped with the following:

- Oil level indicator
- Oil-filling plug
- Oil-drain plug
- Lifting lugs
- Grounding (earthing) terminal for grounding the frame (case)
- A special terminal for measuring $\tan\delta$, which shall be short – circuited during normal operation.

16. Weight of the CT

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

17. Height of the CT

The total height of the CT shall not exceed 2.900mm

VIII. REQUIRED RATING CHARACTERISTICS OF THE CTs

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|---|----------------------------------|
| 1. Primary rated current I_N | : As indicated in attachment "A" |
| 2. Secondaries rated current | : As indicated in attachment "A" |
| 3. Rated Voltage (phase-to-phase) | : 150 kV |
| 4. Highest Voltage | : 170 kV |
| 5. Rated frequency | : 50 Hz |
| 6. Temperature category | : -25 /+ 45 °C |
| 7. Rated continuous thermal current | : $1.2 \times I_N$ |
| 8. Rated Output (of secondary windings) | : As indicated in attachment "A" |
| 9. Rated short-time thermal current (I_{th}) | : 40 kA |
| 10. Rated dynamic current (I_{dyn}) | : 100 kA |
| 11. Limits of temperature rise of the windings
(immersed in oil and hermetically sealed) when they are | |

leaked with the rated continuous thermal current	: 65 K
12. Rated power – frequency withstand voltage	: 325 kV rms
13. Rated lightning impulse withstand voltage	: 750 kV (peak)
14. Creepage distance of the housing	: 4250 mm
15. Chopped lightning impulse withstand	: 863 kV
16. Partial discharge level	: 5pC
17. Power frequency withstand voltage for the secondary windings	: 3 kV
18. Static loading withstand	: 3000 N
19. Dielectric dissipation factor ($\tan\delta$)	: ≤ 0.005 at 10 kV - 98 kV
20. Transmitted overvoltage limit	: $\leq 1,6$ kV (peak) at pulse of 222 kV (peak)
21. Radio interference voltage limit	: $\leq 2500\mu\text{V}$ at 108 kV

IX. TESTS

All testing shall be in accordance with IEC 61869-1 and 61869-2 standards:

A Routine Tests

1. Verification of terminal markings
2. Power-frequency withstand test on primary winding
3. Partial discharge measurement
4. Power-frequency withstand test on secondary windings
5. Power-frequency withstand tests between section of primary winding
6. Inter-turn overvoltage test
7. Accuracy tests (will be executed last)

B Type Tests

1. Short – time current tests
2. Temperature rise test
3. Lightning impulse test
4. Power frequency voltage wet test for outdoor type current transformers
5. Radio interference voltage test
6. Verification of IP degree of protection for the terminal box

C Special Tests (on one CT 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

During the accuracy tests (special tests), the instrument security factor (FS) will be measured for every measuring winding and the accuracy at current corresponding to accuracy limit factor (ALF) will be measured for every protection winding.

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

The terminal markings shall be as indicated below:

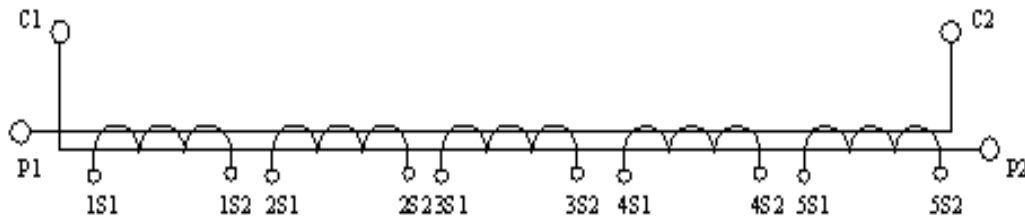


Fig. No. 2

B. Rating Plate markings

All CTs shall bear a plate of non-corrosive material with the following marking:

1. The manufacturer's name
2. Serial number, type, manufacturing year
3. Rated primary and secondary current
4. Rated frequency
5. Rated output and corresponding accuracy class for the secondary windings
6. The highest voltage of the CT
7. The rated insulation level
8. The rated short-time thermal current
9. The rated dynamic current

XI. DATA TO BE SUBMITTED BY BIDDERS

1. All bidders must provide all information requested in "ATTACHMENT B" of this hereby specification. 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 CTs, which will help the technical evaluation process.
3. Technical data for the oil used in the CTs.
4. Drawings showing the outline dimensions of the CTs offered and other information deemed necessary, including terminal markings.
5. Any type test certificates for the type and special tests specified in this hereby specification.

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 CTs construction. The drawings shall include outline dimensional drawing, detail base drawing, wiring drawing and terminal marking drawing. The outline drawing shall include all necessary information, which will enable IPTO to construct the CT'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 four (4) years beginning from the date of delivery of the CTs.

“ATTACHMENT A”

Current transformers 150kV (SS-56)

1. Ratio : 500-1000/1-1-1-1-1 A
2. Primary currents : 500-1000 A
3. Secondary current : 1 A
4. Accuracy class and rated output of the secondary windings
 - a. For the winding used for metering purpose 1S1 – 1S2.
 - Number of windings : 1
 - Rated output . : 30 VA
 - Accuracy class : 0.2S
 - Instrument security factor : FS≤5
 - b. For the winding used for metering 2S1 –2S2.
 - Number of windings : 1
 - Rated output . : 40 VA
 - Accuracy class : 0.2S
 - Instrument security factor : FS≤5
 - c. For protection purpose 3S1 – 3S2
 - Number of windings : 1
 - Rated output . : 30 VA
 - Accuracy class : 5P
 - Accuracy limit factor : 20
 - d. For the protective purpose winding 4S1 – 4S2
 - Number of windings : 1
 - Rated output . : 30 VA
 - Accuracy class : 5P
 - Accuracy limit factor : 20
 - e. For protection purposes 5S1 – 5S2
 - Number of windings : 1
 - Rated output . : 30 VA
 - Accuracy class : 5P
 - Accuracy limit factor : 20

“ATTACHMENT B”
150kV CURRENT TRANSFORMERS (SS-56)

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

1. Type and manufacturer :
2. Ratio :
3. Rated Output and accuracy class of secondary windings
For the winding for metering purpose 1S1-1S2
 - Number of windings :
 - Rated current :
 - Rated output :
 - Accuracy class (measuring class) :
 - Instrument security factor (FS) :For the winding for metering purpose 2S1-2S2
 - Rated current :
 - Number of windings :
 - Rated output :
 - Accuracy class :
 - Instrument security factor (FS) :For protection purpose winding 3S1-3S2
 - Rated current :
 - Number of windings :
 - Rated output :
 - Accuracy limit factor :
 - Accuracy class :For protective purpose winding 4S1-4S2
 - Rated current :
 - Number of windings :
 - Rated output :
 - Accuracy limit factor :
 - Accuracy class :

For the protection purpose winding 5S1-5S2

- Number of windings :
 - Rated current :
 - Rated output :
 - Accuracy limit factor :
 - Accuracy class (measuring class) :
4. Type of housing of CT :
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5. Creepage distance of the Housing :
6. Type of insulating oil :
7. Type of oil-expansion bellows and sealing :
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- 7a. Is the sealing of the transformer ensured by
welding (welded type transformer)
or through "O-RING"? :
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8. Description of the primary terminals in detail :
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9. Description of secondary terminals box :
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10. Description of the metal frame parts :
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11. Installation :
12. Location of the active system of the CT :

13. If active part is not located at the base of the CT, is seismic test certificates or seismic study provided? :
14. Description of accessories :
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15. Rated primary current :
16. Rated Voltage of CT :
17. Highest Voltage of CT :
18. Rated frequency :
19. Temperature category :
20. Rated continuous thermal current :
21. Rated short-time thermal current :
22. Rated dynamic current :
23. Limits of temperature rise of windings :
24. Rated power-frequency withstand voltage :
25. Rated lightning impulse withstand voltage :
26. Chopped lightning impulse withstand voltage :
27. Partial discharge level :
28. Power frequency withstand voltage for the secondary windings :
29. Static loading withstand :
30. Indicate the CT terminal markings :
31. Are the offered CTs with five (5) secondary windings each with its own magnetic core? :
32. Dielectric dissipation factor :
33. Radio interference voltage :
34. Transmitted overvoltage limit :
35. Weight of the CT including oil :
36. Weight of the oil :

37. Are the secondary terminals of the screw type suitable
to be wired with 4 mm² size conductors? :
38. Expected internal resistance of the CT :
39. Height of the CT :
40. Is the housing of silicon rubber? :
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? :