



February 2015

SPECIFICATION SS-54 **400kV CURRENT TRANSFORMERS**

I. SCOPE

This hereby specification covers IPTO's requirements regarding design features, technical characteristics and testing of single-phase, oil-immersed, outdoor, 400kV current transformers.

II. KEY WORDS

Current transformers, instrument transformers, measurement 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 for protection and metering purposes, in 400/150/30kV air insulated EHV 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 400KV ELECTRIC SYSTEM CHARACTERISTICS

- | | |
|--|---------------------------|
| 1. Nominal Voltage (phase to phase) | : 400kV |
| 2. Maximum Operating Voltage (phase to phase): | 420kV |
| 3. Nominal frequency | : 50Hz |
| 4. Short Circuit level | : 40kA |
| 5. Basic Insulation level | : 1550kV |
| 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:

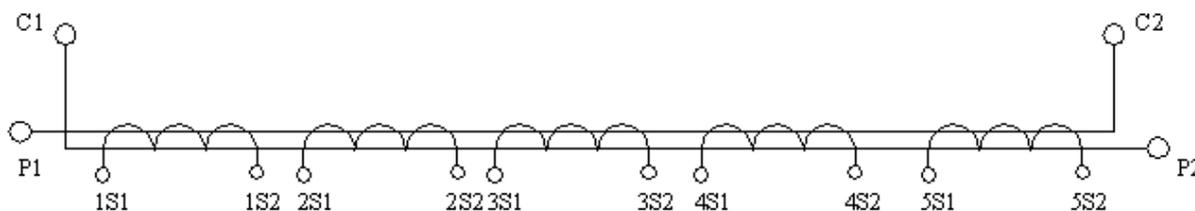


Fig. No. 1

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 of those windings will be used for metering purposes and three 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 be located in the lower part of the CT. It shall be wound as a ring and shall consist of two sections, which can be connected either for 800A or 1600A by means of a switchbox located in the head of the CT. The rating of the primary winding 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 ≥ 10500 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, two (2) on each side of the head of CT, shall be of aluminium or tin-plated copper, cylindrical in shape with each of 30 mm in diameter and with a minimum of 130 mm in length. The distance between the two primary terminals shall be 200 mm. 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.

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 CT. The terminal box shall have protection degree IP55. Each compartment will have suitable hinges in the top part and in the bottom part will be closed without any special tool, by one screw, suitable for the security of the compartments.

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, provided that they follow the requirements of par.VII-15.

14. Weight and dimensions.

The transformer's total weight must not exceed 2600kg and its height must be less than 6000mm.

15. Requirements of seismic qualification

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

- b. The CT's shall be capable of withstanding the following seismic stresses:
 - 1. Horizontally (axes x and y): 0,5g (5m/s²)
 - 2. Vertically (axe z) : 0,25g (2,5m/s²)
 - 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.

16. Accessories

Each CT shall be equipped with the following:

- Oil level indicator visible from the ground
- Oil-filling plug
- Oil-drain plug
- Lifting lugs
- Grounding (earthing) terminal for grounding the frame (case)
- A special terminal for measuring "tanδ", which shall be short-circuited during normal operation.

VIII. REQUIRED RATING CHARACTERISTICS OF THE CTs

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|---|---------------------------------------|
| 1. Primary rated current I_N | : As indicated in the attachment "A" |
| 2. Secondaries rated current | : As indicated in the attachment "A" |
| 3. Rated Voltage (phase – to – phase) | : 400 kV |
| 4. Highest Voltage | : 420 kV |
| 5. Rated frequency | : 50 Hz |
| 6. Temperature category | : -25 /+ 45 °C |
| 7. Rated continuous thermal current | : $1.2I_N$ |
| 8. Rated Output (of secondary windings) | : As indicated in the attachment "A". |
| 9. Rated short – time thermal current (Ith) | : 40 kA |
| 10. Rated dynamic current (Idyn) | : 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 | : 680 kV rms |
| 13. Rated switching impulse withstand voltage (wet) | : 1050 kV (peak) |
| 14. Rated lightning impulse withstand voltage | : 1550 kV (peak) |

15. Creepage distance of the housing	: ≥ 10500 mm
16. Chopped lightning impulse withstand	: 1780 kV (peak)
16. Partial discharge level	: 5pC at 291 kV
18. Power frequency withstand voltage for the secondary windings	: 3 kV
19. Static loading withstand	: 5000 N
20. Dielectric dissipation factor ($\tan\delta$)	: ≤ 0.005 at 10 kV - 243 kV
21. Transmitted overvoltage limit	: $\leq 1,6$ kV (peak) at pulse of 549 kV (peak)
22. Radio interference voltage limit	: $\leq 2500\mu\text{V}$ at 267 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 sections 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 and switching impulse tests
4. Power frequency voltage wet test for outdoor type current transformers
5. Radio interference voltage test
6. Accuracy tests
7. 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. 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

The terminal markings shall be as indicated below:



B. Rating Plate markings

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

1. The manufacturer's name
2. Serial number and type
3. Rated primary and secondary current
4. Rated frequency
5. Rated output and corresponding accuracy class for the secondary windings.
Additionally, for the windings used for measuring, the security factor shall be indicated.
For the windings used for protection the rated accuracy limit factor shall be indicated following the corresponding output and accuracy class.
6. The highest voltage of the CT.
7. The rated insulation level (impulse level)
8. The rated continuous thermal current.
9. The rated short-time thermal current
10. The rated dynamic current
11. Terminal markings of the primary and secondary windings.

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 test certificates for the type, seismic 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 drawings 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
400kV CURRENT TRANSFORMERS

- 1. Ratio : 800-1600/1-1-1-1-1A
- 2. Primary current : 800-1600A
- 3. Secondary current : 1 A
- 4. Accuracy class and rated output of the secondary windings
- a. For the winding used for the main clearing energy 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 the verification of energy metering clearing +bay metering. (2S1 – 2S2)

- Number of windings : 1
- Rated output : 40 VA
- Accuracy class : 0.2S
- Instrument security factor : FS≤5

For the specified accuracy class, the current error and displacement at rated frequency shall not exceed the values shown on the following table:

Percentage of rated primary current:	5%	20%	100%	120%
Percentage current (ratio) error:	0,75	0,35	0,2	0,2
Phase displacement (minutes):	30	15	10	10

- c. For the protection winding used for distance protection No1 (3S1 – 3S2)

- Number of windings : one (1)
- Rated output : 30 VA
- Accuracy class : 5P
- Accuracy limit factor : 20
- Percentage current (ratio) error : ±1,0%
- Phase displacement : ±60minutes
- Composite error at rated accuracy limit primary current : 5%

d. For the winding used for distance protection No2 (4S1 – 4S2)

- Number of windings : one (1)
- Rated output : 30 VA
- Accuracy class : 5P
- Accuracy limit factor : 20
- Percentage current (ratio) error : $\pm 1,0\%$
- Phase displacement : ± 60 minutes
- Composite error at rated accuracy limit
primary current : 5%

e. For protection purposes winding (bus – bar differential relay) (5S1 – 5S2).

- Number of windings : one (1)
- Rated output : 30 VA
- Accuracy class : 5P
- Accuracy limit factor : 20
- Percentage current (ratio) error : $\pm 1,0\%$
- Phase displacement : ± 60 minutes
- Composite error at rated accuracy limit
primary current : 5%

“ATTACHMENT B”
400kV CURRENT TRANSFORMERS

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 used for the main clearing energy metering purpose

- Number of windings :
- Rated current :
- Rated output :
- Accuracy class (measuring class) :
- Instrument security factor (FS) :
- Percentage current (ratio) error :
- Phase displacement (minutes) :

For the winding used for the verification of energy metering clearing +bay metering.

- Number of windings :
- Rated current :
- Rated output :
- Accuracy class (measuring class) :
- Instrument security factor (FS) :
- Percentage current (ratio) error :
- Phase displacement (minutes) :

For distance protection purposes winding No1

- Rated current :
- Number of windings :
- Rated output :
- Accuracy limit factor :
- Accuracy class :
- Percentage current (ratio) error :

- Phase displacement :
- For distance protection purposes winding No2
- Number of windings :
 - Rated current :
 - Rated output :
 - Accuracy limit factor :
 - Accuracy class (measuring class) :
 - Percentage current (ratio) error :
 - Phase displacement :
- For protection purposes (bus-bar differential relay)
- Number of windings :
 - Rated current :
 - Rated output :
 - Accuracy limit factor :
 - Accuracy class (measuring class) :
 - Percentage current (ratio) error :
 - Phase displacement :
4. Type of housing of CT :
 5. Creepage distance of the Housing :
 6. Type of insulating oil :
 7. Type of oil-expansion bellows and sealing :
 - 7a. Is the sealing of the transformer ensured by welding (welded type transformer) or through ‘‘O-RING’’? :
 8. Description of the primary terminals in detail :

8.1 Are the primary terminals two (2) on each side
of the head of CT?

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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

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12. Location of the active system of the CT

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13. If active part is not located at the base
of the CT, is seismic test certificates
or seismic study provided?

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14. Description of accessories

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15. Rated primary current

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16. Rated Voltage

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17. Highest Voltage of CT

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18. Rated frequency

:

19. Temperature category

:

20. Rated continuous thermal current

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- 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. Rated switching impulse withstand voltage :
- 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 :
- 36. Weight of the oil :
- 37. Are the secondary terminals of the screw type suitable
to be wired with 4 mm² size conductors? :
- 38. Height of the CT :
- 39. Expected internal resistance of the CT :
- 40. Indicate terminal markings :
- 41. Is the housing of silicon rubber? :
- 42. Does the Supplier provide a warranty
according to paragr. XIV? :
- 43. Will the package of the transformers follow the
requirements of par. XIII of this hereby specification? :
- 44. Are two compartments provided at the secondary
terminal's box, following par.VII.10? :