

ETS 0009

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Revision History

This specification replaces ETS 0009 amendment no 1. All changes are highlighted in this document with grey colouring.

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1 Documentation Scope

This specification covers the design, manufacture, factory testing and delivery to site of 33kV, 66kV and 132kV outdoor post inductive voltage transformers and post current transformers. It is not the intention to specify all design and constructional details of the station post instrument transformers. However, the equipment supplied shall meet the highest standards of design, engineering and manufacturing practices.

The scope includes all accessories and equipment necessary and normally supplied for the safe operation of the equipment, whether specified or not. The requirement is for self-contained outdoor inductive voltage transformers and current transformers complete with secondary termination box and supporting adaptor plate.

Post instrument transformers offered in response to this specification shall be manufactured and tested to the standards with the year of publication listed in section 3.0 of this document. Endeavour Energy will consider equipment manufactured to other recognised international standards provided the standards are at least equivalent to Australian and/or IEC standards. In some circumstances based on local network experience, this specification is more stringent than the Australian and International standards it references, in this circumstance the requirements of this specification shall prevail. Any proposed variations from this specification shall be referred to the **Engineering Delivery Manager** for approval in writing prior to acceptance.

2 References

External Regulations

Electricity Supply Act 1995

ENA National Electricity Network Safety Code (Doc 001-2019)

Work Health and Safety Act 2011 (NSW)

Work Health and Safety Regulation 2017 (NSW)

External Standards

AS/NZS 1734	1997	Aluminium and aluminium alloys - Flat sheet, coiled sheet and plate
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AS 2344	2016	Limits of electromagnetic interference for overhead AC powerlines and high voltage equipment installations in frequency range 0.15 to 1000MHz
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AS 61869.1	2021	Instrument transformers – General requirements
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AS 61869.2	2021	Instrument transformers Part 1: Current transformers
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AS 61869.3	2021	Instrument transformers Part 2: Inductive voltage transformers
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AS/NZS 60137	2020	Insulated bushings for alternating voltage above 1000 V
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AS 62271.301	2022	High voltage switchgear and control gear - Dimensional standardization of terminals
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SA TS 60815.3 2020 Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems

Company Standards

Equipment Technical Specification ETS 0010	Mineral Insulating Oil
Equipment Technical Specification ETS 0014	Control Panel Fabrication and Installation
Substation Design Instruction SDI 526	Design of Substation Secondary Systems

Company Policies and Procedures

Company Policy 9.1.8	Network Configuration
Company Policy 9.2.5	Network Asset Design
Company Policy 9.7.1	Network Construction
Branch Procedure PAE 1004	Product Approval Process

3 Definitions and Abbreviations

Term	Definition
AEMO	Australian Energy Market Operator
Burden	The impedance connected to the CT secondary winding.
CT	An instrument transformer in which the secondary current, in normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections
Class PX	A PX class transformer of low leakage reactance for which knowledge of the transformer secondary excitation characteristic, secondary winding resistance, secondary burden resistance and turns ratio is sufficient to assess its performance in relation to the protective relay system with which it is to be used.
DDF	Dielectric dissipation factor, also referred to as DLA.
Exciting Current (I _e)	The r.m.s value of the current taken by the secondary winding of a current transformer, when a sinusoidal voltage of rated frequency is applied to the secondary terminals, the primary and any other windings being open circuited ¹ .
Fault level	three-phase balanced fault level
HV	High voltage – A voltage normally exceeding 1,000 volts alternating (a.c) or 1,500 volts direct current (d.c).
Knee point voltage	The minimum sinusoidal voltage (rms) applied to the secondary terminals of a current transformer at rated power frequency when applied to the secondary terminals of the CT, all other terminals being open - circuited, which when increased by 10% causes the r.m.s exciting current (I _e) to increase by no more than 50%. Rated knee point is represented by E _k .
LV	Low voltage – A voltage normally exceeding 50 volts alternating current (a.c) or 120 volts direct current (d.c), but not normally exceeding 1,000 volts alternating (a.c) or 1,500 volts (d.c).
NATA	National Association of Testing Authorities
NEM	National Electricity Market
RIV	Radio interference voltage
SCADA	Supervisory Control and Data Acquisition
Rated continuous thermal secondary current	The value of the current which can be permitted to flow continuously in the secondary winding, when the secondary winding being connected to the rated burden, without the temperature rise exceeding the values specified.
U _r	Rated voltage
VT	Voltage transformer, an instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.

4 Actions

4.1 General requirements

4.1.1 General

Outdoor post instrument transformers supplied shall be designed and manufactured in conformance with AS 61869.1, AS 61869.2 and AS 61869.3, except where specifically varied in this specification.

The design and construction shall be in accordance with the technical requirements stated in this Equipment Technical Specification. All materials shall be of the type and quality that shall give a normal life expectancy of at least 45 years.

Post instrument transformers shall be designed, manufactured and tested for outdoor service conditions to minimise safety hazard to personnel, prevent accidental short circuiting by human error and prevent access of spiders, birds or rodents.

Post instrument transformers shall be oil or solid insulated. Insulation systems other than oil or solid insulation may be considered by Endeavour Energy but should be submitted as a separate offer in full for consideration of the Engineering Delivery Manager.

Bushings for post instrument transformers shall comply with AS 60137. The bushing shall either be porcelain or polymeric¹ (silicon rubber), light grey colour, similar to smoke blue (refer to T33 of AS 2700). EPDM bushings are not acceptable.

All connections shall be terminated using crimp lugs and stainless steel or hot dip galvanised bolts, as appropriate. Clamps or u-bolt connections are not acceptable.

All design values submitted in the offer shall be guaranteed values and shall be treated as such in the evaluation when assessing whether the delivered equipment meets the specification and when accepting goods to stores.

The technical requirements for the post instrument transformers shall be as indicated in the technical descriptions for each of the categories stated below.

The supply of the post instrument transformers shall include everything necessary or usually supplied for the operation of the equipment whether directly supplied or not.

Summary of specific requirements and definition of accuracy classes for voltage transformers and current transformers are specified in Annexures 1, 2 and 3.

All technical parameters shall have a guaranteed value that the supplier shall enter, as appropriate, in the technical schedules and guarantees referred in section 4.9 product approval forms Branch Form FAE 3137 and Branch Form FAE 3138 of this Equipment Technical Specification.

External surfaces shall be as set out in 4.5, internal surfacing shall be as set out in 4.2.12. Internal galvanised surfaces are not acceptable.

4.1.2 Testing requirements for post instrument transformers

All type, routine tests and acceptance tests required by the above standards shall be performed and one copy of each of the test reports shall be submitted to the Engineering Delivery Manager.

¹ SA TS 60815 – Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems

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Where special tests are required in addition to the above, the cost of these is to be included in the tender pricing. The supplier shall submit details of type, routine and special tests that are performed, as standard, to the various components during and on completion of manufacture.

All tests shall be carried out by a testing authority holding appropriate accreditation:

- by NATA Australia; or,
- by an accreditation authority recognised by NATA Australia.

Type and routine tests carried out at the manufacturer's testing facilities may be accepted provided the facilities are pre-qualified by the **Head of Asset Planning & Performance** to perform the tests.

The pre-qualification requires an inspection of the manufacturer's factory and the testing facility by a nominee of the **Chief Asset & Operating Officer**.

Tests from other testing authorities, such as KEMA may be accepted at the discretion of the **Head of Asset Planning & Performance**.

Type test reports shall be less than five years old. However, certificates more than five years old may be accepted at the discretion of the **Head of Asset Planning & Performance**, provided clear evidence is submitted to show that the manufacturing processes, quality controls and supply chains have not changed during that period.

Endeavour Energy reserves the right to witness the type, routine, acceptance or batch tests, for which at least four weeks' notice shall be given.

All routine tests shall be carried out in accordance with the applicable standards on each of the instrument transformer unit and complete report for each routine test shall be submitted to Endeavour Energy as part of the Factory Acceptance Testing (FAT). All FAT reports shall be approved first before the equipment is dispatched from the factory.

Test reports written in any language other than English shall not be accepted by Endeavour Energy unless such reports are translated into English by a sworn translator.

When delivering instrument transformers, measurement error test certificates must be provided by successful tenderers. However, all costs incurred in measurement error testing and certifications shall be included in the tender pricing by all participating tenderers (refer to section 4.6 for further requirements on measurement error test certificates).

4.1.3 Service conditions

Service conditions for voltage and current transformers shall be in accordance with **AS 61869.1, AS 61869.2 and AS 61869.3**. As a minimum, these transformers shall be designed to operate in service conditions as set out in Table 1.

Table 1 - Service conditions

Description	Requirement
Altitude	<1000 m
Maximum ambient temperature	45 deg. C
Minimum ambient temperature	-10 deg. C
Annual keraunic days	30
Solar radiation - maximum	1.1 kW/m ²
Average index of mean relative humidity: 9:00am	95 %
Seismic acceleration coefficient (maximum)	0.09

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Pollution level	Level IV
Ice coating	1 mm
Wind speed	34 m/s
Condensation/precipitation	Yes
Duration for temperature drop by 20 deg. C	20 minutes

The design and construction of each instrument transformer unit shall be such that it shall not cause any radio interference. The guaranteed values of RIV shall be stated in technical schedules of this Equipment Technical Specification in accordance with AS 61869.1. Preference shall be given to equipment with lower values.

The equipment shall be mounted in an outdoor switchyard on steel supporting pedestals provided by Endeavour Energy.

4.2 Post Inductive Voltage Transformers

4.2.1 General requirements

The voltage ratings of post inductive voltage transformers supplied under this specification shall be as specified in Annexure 1 and Annexure 2.

4.2.2 Specific performance requirements

Construction

Voltage transformers shall be designed and constructed as single phase units, electromagnetic and naturally cooled.

Duty

The duty of voltage transformers shall be general tariff metering and protection. A summary of specific requirements and definition of accuracy class for post inductive voltage transformers is set out in Annexure 2.

4.2.3 Name Plate and VT Details

The equipment nameplate details and the voltage transformer details shall be stamped on laser etched stainless steel plate and attached to each of the single phase voltage transformer tanks.

The nameplate shall be easily readable in all lighting conditions.

All symbols, units and values shall be represented clearly and correctly on the nameplate.

The rating plate shall conform to the markings and appropriate information specified in AS 61869.3.

4.2.4 Degree of protection

The degree of protection class for voltage transformer secondary wiring cubicle shall be IP54.

4.2.5 Rated burden

The rated VA burden shall be as specified in Annexure 2.

4.2.6 Core

Voltage Transformers shall be constructed from single phase magnetic core.

4.2.7 Tank earthing terminals

The tank shall have two unpainted stainless steel or galvanised earthing terminals welded on opposite sides of the tank, near the bottom (refer to Figure 1 for dimensions).

The earthing terminal dimensions shall match a type 4 terminal palm from AS 62271.301. Each of the bolt holes on the terminal shall be 14mm in diameter.

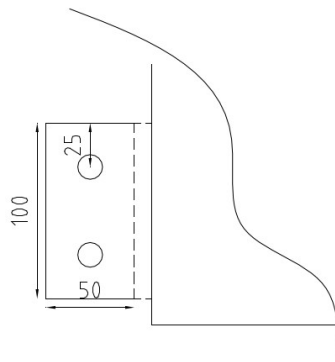


Figure 1 - Earth terminal welded to outside of tank

4.2.8 HV Terminals

Upwards mounting HV terminals shall be fitted and the connection of windings to the terminals shall be below oil level. The end of the HV winding that shall form part of the star point shall be earthed externally through a link to the tank. A warning label for the earthing terminal connection shall be fixed next to the VT secondary connection diagram. The label shall read:



Outdoor bushings shall be provided for the 33kV, 66kV and 132kV terminations.

4.2.9 Termination palms

The material of the palm shall be aluminium alloy 6061 to AS 1734 or equivalent. Termination palms shall be supplied fitted to the 33kV, 66kV and 132kV VT connections to enable Endeavour Energy to complete the busbar connections. Termination palms shall be Type 7 in accordance with AS 62271.301.

Lugs and bolts for connection of conductors to VT terminal palms shall be provided by Endeavour Energy.

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All bus bar connections shall be free of sharp edges to reduce radio interference voltages/corona.

The supplier shall provide a typical general arrangement drawing showing terminal details and locations with their tender submission. The terminal palm arrangement shall be finalised prior to finalising the contract.

4.2.10 Conservator

An oil conservator tank may be fitted, if required by the manufacturer. All gasket joints of the tank body shall be at a level lower than the nominal oil level so that any leaks can be detected.

4.2.11 Lifting facilities

The voltage transformer shall be provided with suitable steel lifting lugs. Lifting instructions shall be fitted to the outside of the VT tank showing slinging method, centre of gravity, and weight. The label shall be etched on stainless steel.

4.2.12 Insulating oil and containment system

The transformer shall be provided with new inhibited mineral oil, as set out in Endeavour Energy ETS 0010 and shall not contain PCB or other contaminants.

All voltage transformers that have their insulating system sealed from the atmosphere shall allow for expansion with the use of stainless steel bellows and shall incorporate in their design facilities to monitor the condition of the equipment. The facilities shall include pressure release/explosion venting and oil level indication as a minimum. Moisture in the insulating system shall be less than 0.5%.

The pressure relief device shall be designed to relieve any internal abnormal pressures before the likelihood of fracture of any external component of the transformer. The relief device shall be positioned near the top and oriented to prevent the possibility of injury or damage to persons or other equipment.

4.2.13 Oil sampling valve

An oil sampling valve shall be fitted at the bottom of the oil containment tank.

4.2.14 Oil level indication

An oil level indicator shall be fitted on the oil containment tank. The oil level indicator is to be clearly visible from ground level without the aid of optical devices and be suitably marked to indicate the correct level at 20 deg. C, 40 deg. C and 60 deg. C.

4.2.15 Testing

As a minimum, the type tests indicated in Table 2 shall be carried out for each category of post inductive voltage transformers.

Table 2 - Type tests for post inductive voltage transformers

Type test	Acceptable value	Test method reference
1. Temperature rise test	As per temp rise limits specified in AS 61869.1 (relative to type) and attain a steady state temp when rate of rise does not exceed 1K per hour .	AS 61869.1 Cl. 7.2.2 & AS 61869.3 Cl. 7.2.2
2. Short-circuit withstand capability test	Satisfies conditions a) to d) in clause 7.2.301 of AS61869.3	AS 61869.3 Cl.7.2.301
3. Lightning impulse test	Satisfies conditions in clause 7.2.3.2 of AS 61869.1 and AS 61869.3	AS 61869.1 Cl. 7.2.3.2 & AS 61869.3 Cl. 7.2.3.2
4. Wet test (performed with power frequency voltage)	No flashover	AS 61869.1 Cl. 7.2.4
5. Determination of errors for measuring voltage transformer cores	According to table 301 of AS 61869.3	AS 61869.3 Cl. 7.2.6.301
6. Determination of errors for protective voltage transformer cores	According to table 302 of AS 61869.3	AS 61869.3 Cl. 7.2.6.302
7. Chopped lightning impulse test on primary winding	No differences in wave shape in full wave application before and after the chopped impulses	AS 61869.1 Cl. 7.4.1
8. Measurement of capacitance and DDF test (before and after the impulse test)	≤ 0.005 {equivalent to 5 mW/War (mrad)} @ 20 deg C	AS 61869.1 Cl. 7.4.3 AS 61869.3 Cl. 7.4.3
9. Mechanical test	No evidence of damage	AS 61869.1 Cl. 7.4.5
10. Transmitted overvoltage measurement	According to table 9 of AS 61869.1	AS 61869.1 Cl. 7.4.4
11. Radio interference voltage (RIV) measurement	Satisfy clause 6.11.2 of AS 61869.1	AS 61869.1 Cl. 7.2.5.1

All routine test reports, as set out in AS 61869.1 and AS 61869.3, resistance measurements, and accuracy checks shall be provided. As a minimum, the routine tests indicated in Table 3 shall be carried out for each post inductive voltage transformers supplied to Endeavour Energy.

Table 3 - Routine test for post inductive voltage transformers

Type test	Acceptable value	Test method reference
1. Verification of terminal marking	Verified by manufacturer	AS 61869.1 Cl. 7.3.6 AS 61869.3 Cl. 6.13.301
2. Power frequency withstand test on primary windings	According to table 2 of AS 61869.1	AS 61869.1 Cl. 7.3.1 AS 61869.3 Cl. 7.3.1
3. Partial discharge test PD Test Voltage: 1.2 Um / $\sqrt{3}$ (Phase-to-earth)	As set out in table 3 of AS 61869.1	AS 61869.1 Cl. 7.3.2 AS 61869.3 Cl. 7.3.2

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4. Power frequency withstand test on secondary windings	No disruptive discharge @ 3kV r.m.s.	AS 61869.1 Cl. 7.3.4
5. Power frequency tests between sections	No disruptive discharge @ 3kV r.m.s.	AS 61869.1 Cl. 7.3.3
6. Determination of errors for measuring VT cores	As set out in table 301 of AS 61869.3	AS 61869.3 Cl. 7.3.5.301
7. Determination of errors for protective measuring VT cores	As set out in table 302 of AS 61869.3	AS 61869.3 Cl. 7.3.5.302
8. Measurement of capacitance and DDF Test (Before and after the impulse test)	≤ 0.005 {equivalent to 5 mW/Var (mrad)} @ 20 deg C	AS 61869.1 Cl. 7.4.3 AS 61869.3 Cl. 7.4.3
9. Insulation resistance (primary circuit)	$> 0.5 \text{ G}\Omega$ @ 20 deg C at test voltage 5kV DC	-
10. Insulation resistance (secondary circuit)	$> 1 \text{ M}\Omega$ @ 20 deg C at test voltage 500V DC	-
11. Polarity test	Serviceable	-

4.3 Post current transformers

The post current transformers supplied under this specification shall be single phase outdoor units. These shall be suitable for use in Endeavour Energy's 33kV, 66kV and 132kV transmission and zone substation, or in a switching station on a 3 phase, 50Hz system, earth fault factor up to 1.8.

The values of system highest voltages, ultimate maximum fault level for one (1) second lightning impulse withstand voltage, power frequency withstand voltage, pollution levels and bushing colour shall be as set out in Annexure 1. Further technical requirements are provided in Annexure 3. The supply voltage waveform is for all practical purposes sinusoidal and the supply voltages are symmetrical.

The design and construction shall be in accordance with the technical requirements stated. All materials shall be of a type and quality that shall give normal life expectancy without deterioration.

Post current transformers shall comply with Australian Standard AS 61869.2 and technical schedules and guarantees as set out in Branch Form FAE 3137 and Branch Form 3138.

Wiring and terminal/links shall be arranged to enable the easy changing of CT ratios.

4.3.1 Specific requirements

Post current transformers shall be constructed as single phase naturally cooled units having a combination of protection and metering cores. Hair pin design CTs are not acceptable. A summary of specific requirements and definition of accuracy classes for each type of current transformers is set out in Annexure 3.

4.3.2 Secondary winding rated continuous thermal current

The secondary winding of CTs shall be capable of continuously carrying a current not less than two times the rated secondary current.

4.3.3 Other metering current transformer requirements

No interposing CTs or other devices shall be used for metering current transformers. CTs must not have turns compensation. The Instrument Security Factor (ISF) shall be set at 10 on the lowest ratio for all metering cores of current transformers. The ISF shall be indicated on the rating plate of measuring CTs data following the indication corresponding rated output. For example, 5VA class 0.2 FS 10.

4.3.4 Nameplate and CT details

The equipment nameplate details and the CT details shall be stamped on laser etched stainless steel plate and attached to the CT tank. The nameplate shall be easily readable in all lighting conditions. All symbols, units and values shall be represented clearly and correctly on the nameplate. The rating plate shall conform to the markings and appropriate information specified in section 16.3 of AS 61869.2.

4.3.5 Degree of protection

The degree of protection class for post current transformers shall be IP54.

4.3.6 Earthing terminals

The bottom housing at the base of the CT shall have two unpainted stainless steel or galvanised earthing terminals welded to each of the opposite sides of the housing near the bottom (refer to Figure 1 for dimensions). The earthing terminal dimensions shall match a type 4 terminal palm from 62271.301.

4.3.7 Core

The transformer core shall be of wound type with material of very high permeability.

4.3.8 Insulating oil and its containment system

The interior of all oil containment tanks shall be oil resistant lacquer paint finish. Oil insulated current transformers shall be provided with new inhibited mineral oil, as set out in ETS 0010, and shall not contain PCB or other contaminants.

All oil insulated current transformers that have their insulating system sealed from the atmosphere shall allow for expansion with the use of stainless steel metal bellows, and shall incorporate in their design facilities to monitor the condition of the equipment. The facilities shall include pressure release/explosion venting and oil level indication as a minimum. Moisture in the insulating system shall be less than 0.5%.

The pressure relief device shall be designed to relieve any internal abnormal pressures before the likelihood of fracture of any external component of the transformer. The relief device shall be positioned near the top and oriented to prevent the possibility of injury or damage to persons or other equipment.

The diaphragm/level indicator and pressure gauge facilities shall be clearly visible from ground level. Any gasket joint shall be at a level lower than the nominal oil level so that any leak can be detected.

Current transformer secondary leads shall be provided with seals to prevent oil migration to the secondary terminal blocks.

4.3.9 Oil sampling valve

An oil sampling valve shall be fitted at the bottom of the oil containment tank.

4.3.10 Busbar termination

Termination palms shall be supplied fitted to the CT connections to enable Endeavour Energy to complete the busbar connections.

Termination palms shall suit the rating of the equipment, for example, Type 8 in accordance with AS 62271.301. Both faces of the palm shall be current carrying surfaces.

The contractor shall supply the terminal palms and Endeavour Energy is to supply connecting lugs and bolts. The material of the palm shall be aluminium alloy 6061 to AS 1734 or equivalent.

For post current transformers, the terminals are to be preferably flat horizontal palms, as specified above. Terminals shall be on the same centre line (in plan view) so that busbars provided by Endeavour Energy are in a straight line.

4.3.11 Testing

As a minimum, the type tests indicated in Table 4 shall be carried out for each category of post current transformers.

Table 4 - Type tests for post current transformers

Type test	Acceptable value	Test method reference
1. Short time current test	According to items a) to d) in clause 7.2.201 of AS 61869.2 Cl 7.2.201	AS 61869.2 Cl 7.2.201
2. Temperature rise test ²	As per temp rise limits specified in AS 61869.1 (relative to type) and attain a steady state temp when rate of rise does not exceed 1K per hour (refer note 2 also).	AS 61869.1 Cl. 7.2.2 & AS 61869.2 Cl. 7.2.2
3. Lightning impulse test	Satisfies conditions in clause 7.2.3.2 of AS 61869.1	AS 61869.2 Cl. 7.2.3.2
4. Wet test (performed with power frequency voltage)	No flashover	AS 61869.2 Cl. 7.2.4
5. Determination of errors for measuring CT	As set out in tables 201 of AS 61869.2	AS 61869.2 Cl. 7.2.6.201
6. Determination of errors for protective CT	As set out in tables 205 of AS 61869.2	AS 61869.2 Cl. 7.2.6.203
7. Chopped lightning impulse test on primary winding	No differences in wave shape in full wave application before and after the chopped impulses	AS 61869.1 Cl. 7.4.1

² The temperature rise test, as set out in AS 61869.1, shall demonstrate that the specified temperature rise will not be exceeded under any combination or ratio, primary current and secondary current up to their respective thermal ratings at an ambient temperature of 45 deg. C.

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8. Measurement of capacitance and DDF Test (Before and after the impulse test)	≤ 0.005 {equivalent to 5 mW/Var (mrad)} @ 20 deg C	AS 61869.1 Cl. 7.4.3 AS 61869.2 Cl. 7.4.3
9. Mechanical tests	No evidence of damage	AS 61869.1 Cl. 7.4.5
10. Transmitted overvoltage measurement	As set out in table 9 of AS 61869.1	AS 61869.1 Cl. 7.4.4
11. Radio interference voltage (RIV) measurement	Satisfy clause 6.11.2 of AS 61869.1	AS 61869.1 Cl. 7.2.5.1
12. Secondary insulation resistance for each type of class of PX CTs having: - Rated knee point of $E_k \geq 2\text{kV}$ - Power frequency withstand 5kV r.m.s for 60s. - Rated knee point of $E_k < 2\text{kV}$ - Power frequencies withstand 3kV r.m.s for 60s.	No disruptive discharge.	AS 61869.2 Cl. 5.3.5
Additional type tests for each type of class PX current transformers		
12.a Proof of low reactance type	As set out in AS 61869.2 Annex 2C	AS 61869.2 Annex 2C

As a minimum, the routine tests indicated in Table 5 and 6 shall be carried out for each post current transformer supplied to Endeavour Energy.

Table 5 - Routine tests for post current transformers

Routine test	Acceptable value	Test method reference
1. Verification of terminal markings	Verified by manufacturer	AS 61869.1 Cl. 7.3.6 AS 61869.2 Cl. 6.13.201
2. Power frequency withstand tests on primary windings	As set out in table 2 of AS 61869.1	AS 61869.1 Cl. 7.3.1 AS 61869.2 Cl. 7.3.1
3. Partial discharge (PD) test measurement PD Test voltage: $1.2 U_m / \sqrt{3}$ (Phase-to-earth)	As set out in table 3 of AS 61869.1	AS 61869.1 Cl. 7.3.2
4. Power frequency withstand tests on secondary windings	No disruptive discharge @ 3kV r.m.s.	AS 61869.1 Cl. 7.3.4
5. Power frequency withstand tests between sections	No disruptive discharge @ 3kV r.m.s.	AS 61869.1 Cl. 7.3.3
6. Inter-turn over voltage test Test voltage = 4.5kV peak. For $V_k > 450V$; 10kV peak or 10 X rated knee point emf whichever is lower	No inter-turn short circuit	AS 61869.2 Cl. 7.3.204
7. Determination of errors for measuring current transformer cores	As set out in table 201 of AS 61869.2	AS 61869.2 Cl. 7.2.6.201
8. Determination of errors for protective current transformers cores ³	As set out in table 205 of AS 61869.2	AS 61869.2 Cl. 7.2.6.203
9. Dielectric Dissipation Factor (DDF) Test ⁴	0.005 {equivalent to 5 mW/Var (mrad)} @ 20 deg C	AS 61869.1 Cl. 7.3.4 AS 61869.2 Cl. 7.3.4
10. Insulation resistance (primary circuit)	> 0.5 GΩ @ 20 deg C at test voltage 5kV DC	-
11. Insulation resistance (secondary circuit)	>1 MΩ @ 20 deg C at test voltage 500V DC	-
12. Magnetisation (excitation current) test ⁵	Knee transition point between normal operation and saturated region must be above CT burden rating	CT excitation test method
13. Polarity test	Serviceable	-
14. Ratio test	Serviceable	-

³ These tests shall be carried out on each of the sets of ratios for each of the protective cores.

⁴ Applicable for 66kV and 132kV CTs

⁵ The test shall include minimum of fifteen test points in order to determine any variation in knee transition point.

Table 6 - Additional routine test requirements for each type of class PX current transformers

Routine test	Acceptable value	Test method reference
1. Rated knee-point e.m.f. (E_k) and maximum exciting current (I_e)	Exciting current (I_e) at the rated knee point e.m.f. or at any rated percentage shall not exceed the rated limit.	AS 61869.2 Cl. 7.3.203
2. Secondary winding resistance (R_{ct})	Corrected to 75 deg C - Not exceeding specified upper limit	AS 61869.2 Cl. 7.3.201
3. Turns ratio error	As set out in AS 61869.2 Cl. 5.6.202.4	AS 61869.2 Cl. 7.3.206
4. Secondary insulation resistance for each type of class of PX CTs having: - Rated knee point of $E_k \geq 2\text{kV}$ - Power frequency withstand 5kV r.m.s for 60s. - Rated knee point of $E_k < 2\text{kV}$ – Power frequencies withstand 3kV r.m.s for 60s	No disruptive discharge	AS 61869.2 Cl. 5.3.5

4.4 Secondary terminations, wiring and minimum enclosure

4.4.1 Secondary enclosure

A weatherproof secondary terminal enclosure is required on the side of the tank in each of the standalone instrument transformers in an accessible location. The degree of protection of the secondary enclosure against ingress of dirt and water shall be IP54.

The LV terminals and through bushings shall be installed in such a way that tightening the terminals shall not compromise the oil seals.

Cable glands provided in the terminal enclosure shall be suitable for up to 4mm² six core 7/0.67, 0.6/1kV copper foil screened cable.

Secondary leads shall be provided with seals to prevent oil migration to the secondary terminal blocks.

4.4.2 Wiring

All wiring shall be carried out in accordance with section 7 of ETS 0014

All external cabling shall be supplied and terminated by Endeavour Energy. All internal wiring shall be provided by the supplier.

4.4.3 Secondary cable terminations and terminal blocks

The acceptable terminal blocks to be used are as indicated in section 7 of ETS 0014.

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All control cables (internal panel wiring and external control cables) shall be terminated in accordance with section 7 of ETS 0014.

Current transformer terminal blocks shall comply with the requirements set out in SDI 526, and shall be of the bolt type (min. 5mm) or tunnel connectors.

For current transformers, the terminals and leads shall be clearly marked with secondary terminal markings to in accordance with AS 61869.2 and AS61869.2. They shall show the current transformer group number in which the current transformer is mounted (for example, 3S2 - terminal number S2 of the third group). Wiring shall be arranged so as to enable the changing of ratio. A removable blank plate shall be provided for Endeavour Energy to drill to accommodate four glands, each having an overall diameter of 60mm. All cable entries shall be directed to the ground.

For voltage transformers, the terminal markings shall be in accordance with AS 61869.3 (refer to the drawing in Annexure 3 showing the mandatory customer interface).

4.5 Surface finish

Surface or external finish for post instrument transformers shall be hot dipped galvanised to AS 4680. For internal finish refer to clause 5.3.10.

All support structures used for post instrument transformers shall have a hot dipped galvanised finish to AS 4680. The galvanised finish thickness shall be 85 micrometres.

4.6 Health, safety and environment (HSE) requirements

4.6.1 Special environmental requirements - toxicology safety

The supplier shall provide with the offer, full details, including composition and toxicological information, regarding the health and safety aspects of all the materials offered in their offer or supplied equipment regardless of content.

Recommended procedures shall be provided for the safe handling, safe operation and maintenance of products supplied. The means of disposal of the materials shall be clearly stated.

Material safety data sheets (MSDS) shall be provided, with copies available on site, for materials that are supplied and subject to safety considerations in handling and use.

All equipment, packaging and all other accessories provided shall be asbestos free.

The above information is required as part of the offer and will be reviewed as part of the tender process.

4.6.2 Noise levels and radio interference voltage (RIV)

The equipment may be installed in a residential area in close proximity to family residences. Noise and radio interference voltage shall be kept to the minimum levels to comply with all the requirements of AS/NZS 2344:1997.

4.6.3 Fire and blast hazards

The post instrument transformers shall be designed in a manner to eliminate the risk of rupture and explosive failure and subsequent personnel and fire risk. Where pressurised gas is used or a rapid pressure increase could cause safety hazards to employees or other equipment, the use of appropriately placed pressure release diaphragms and venting positioning shall be provided.

4.7 Measurement error test certificates (applies to both VTs and CTs)

The NEM Rules and AEMO Metrology Procedures require that Measurement Error Test Certificates be provided for CTs and VTs to conform to the relevant Standards' class requirements.

These certificates must include statements of the respective Testing Uncertainty, and the results must have been obtained by use of Reference Standard CTs and VTs, or other internationally recognised methods, whose calibration is traceable either to:

- the Australian National Measurement Laboratory; or,
- Standards of some other national measurement laboratory recognised by NATA under the International Laboratory Accreditation Corporation (ILAC) mutual recognition system.

4.8 Packing and Transport

The supplier to this specification is responsible for the transportation between a manufacturer's works and the site nominated by Endeavour Energy within Endeavour Energy's franchise area.

The costs, risks and responsibilities for transportation are the responsibility of the supplier. This include the responsibility for the load profile for each transport mode, transport route, the means of transport, any necessary route alteration, statutory approval or licenses, shipping reservations and documentation or any other requirement concerning the delivery of the instrument transformers to the nominated site.

The supplier shall provided information on the correct method of storing the instrument transformers for both short and long term periods of time.

4.8.1 Design for transport

The instrument transformers and packaging shall be of a robust design and safeguarded for transportation, capable of withstanding any shock to which it may be subjected to during transport taking all planned transport modes into consideration. Necessary mechanical withstand capability shall be built into the design. Endeavour Energy requires the installation on the packaging of suitable shock indicators based on the equipment design to indicate no equipment damage has occurred during transport. All equipment damage shall be the responsibility of the supplier.

4.8.2 Packing

The supplier shall suitably pack each instrument transformer in a wooden crate having all accessories and components clearly marked for identification and inspection.

The following shipping mark, approximately 75mm high, is to be clearly marked on all cases and packages:

(Voltage) kV, Voltage Transformer or Current Transformer

ENDEAVOUR ENERGY

CONTRACT NO:

CONTRACTOR'S NAME:

All measures shall be taken to prevent damage during packing, transporting and dismantling.

4.9 Product approval

4.9.1 Product approval and audit forms

Complete information of the equipment shall be provided in technical schedules and guarantees as set out in Branch Form FAE 3137 and Branch Form 3138.

4.9.2 Product approval process

The equipment shall be evaluated under the product approval process set out in Branch Procedure PAE 1004 – Product Approval Process. The Engineering Delivery Manager will approve the equipment / components for use on the network.

4.10 Quality assurance

Quality assurance certification is required to review the manufacturer's ability to design and consistently manufacture instrument transformers to this specification. The supplier and all its contractors shall have a quality system that complies with the requirements of AS/NZS ISO 9001 or other comparable Australian or International equivalent.

All nominated drawings and documents that have to be reviewed by Endeavour Energy are to be submitted as complete packages using document controls systems such that all the relevant information to enable the design to be reviewed are available. Design suitability approval will not relieve the supplier of its responsibilities for the correctness and appropriateness of the design or their responsibility to conform to this specification.

4.10.1 Quality assurance plan

A quality assurance plan is to be provided as part of the tender; it shall be a document subject to approval of Endeavour Energy and shall contain as a minimum the following information:

- The supplier's organisational structure for the works.
- A planned outline meeting the requirements and all stages of the scope and specification.
- An index showing all existing procedures, inspection and test plans and drawings.
- AS/NZS ISO 9001 certification for itself and subcontractors.
- A plan detailing the design, ordering of materials, manufacturing and test plans.

4.10.2 Operations and maintenance manual

The manufacturer/supplier shall submit the following documentation prior to delivery of the equipment to Endeavour Energy as follows:

The supplier shall provide a hard copy manual for each of the VTs and CTs supplied to Endeavour Energy. The manual shall be A4 size and complete with routine test reports, and suitably folded or reduced but legible drawings for filing within the manual. All text, including titles and legends on the documents, shall be in English, with the dimensions in metric.

Hard copy manuals shall be professionally presented in hard cover ring-binder files capable of withstanding normal handling.

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Two electronic copies of the completed manual shall be saved onto a DVD disk or flash drive and submitted with the hard copy manual. The preferred file format for equipment manuals is Microsoft Office 2010 or PDF (Portable Document Format). Drawings shall be in AutoCAD (Release 2010).

The manual and the DVD shall be complete with the following minimum requirements:

- Brief description of the equipment example brand name, type and model number.
- Substation name (if known), for which the equipment was supplied.
- Endeavour Energy contract number.
- Manufacturer's order number and suppliers address.

The manuals shall be complete with the following minimum requirements:

- A comprehensive index.
- MSDS of all hazardous or flammable material used in the equipment.
- Precise instructions on inspecting, installing and making connections, operating, testing, maintenance and disposal.
- Transformer section drawing.
- Unpacking of current transformers - drawings
- Instructions for the routine maintenance and testing (including oil sampling) of the equipment.
- Certificate of oil quality.
- Name plate.
- Electrical diagram.
- Outline drawing.
- Information about terminal mounting.
- DDF test tap terminal drawing for CTs.
- Warning plate for DDF test tap drawing (for CTs).
- Drawings showing all internal section and external view of secondary termination box for CTs and LV termination enclosure for VTs.
- Recommended maintenance regime including maintenance tasks and intervals.
- Recommended tests to be carried out throughout the life of the instrument transformers, including the pass/fail criteria for each test shall be included in the manual.
- Pamphlets.
- Applicable certified test certificates for type, routine and special tests including factory test reports added to the manual as set out in section 5.1.1 and 5.6.
- Work as executed drawings (Work instructions necessary for the installation of the outdoor post instrument transformers shall be incorporated in the work as executed drawings).
- Equipment manuals from secondary equipment manufacturer if applicable.

4.10.3 Additional information

The following information shall also be submitted:

- A list of recommended spares and tools, with prices and availability of each item.
- Details of technical back-up facilities available.

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- Details of equipment operating history, including how many in service, where, and for what period, plus reference contact names and numbers.
- Mean Time Between Failure (MTBF) and the critical failure modes identified by the failure mode, effects and criticality analysis (FMECA) of the equipment. Details substantiating the FMECA analysis shall be included.

4.11 Maintenance requirements

4.11.1 Maintenance instructions

The supplier shall provide detailed instructions for the maintenance of the instrument transformers.

4.11.2 Spare parts

The supplier shall supply a list of recommended spare parts, special tools and appliances required for the whole of life operation and maintenance of the instrument transformer installation. The list, together with prices, shall be indicated in the appropriate schedule.

The supplier must also provide details of the recommended maintenance and the frequency at which it must be carried out. Special tools are to be part of the main contract.

The items nominated must allow most common defects to be repaired and recommended maintenance to be carried out expeditiously over the whole life of the instrument transformers.

Predicted availability and compatibility of ex-stock parts over the life of the instrument transformers will be considered. Lists shall be complete with part numbers and current prices for each item. Where identical items have been supplied to Endeavour Energy as spares on previous contracts, details of the quantity and type supplied shall be provided.

The final quantities of spares to be supplied will be decided as part of contract negotiation.

5 Authorities and Responsibilities

Chief Asset & Operating Officer has the authority and responsibility for:

- approving this specification, including any variations;
- nominating Endeavour Energy's representative(s) for either the manufacturing facility inspection and/or witness testing;
- approving dispensation from this specification where the risk is considered High or Extreme in accordance with Endeavour Energy's risk management procedures; and
- delegating any of these authorities and responsibilities to the Head of Asset Planning & Performance

Head of Asset Planning & Performance has the authority and responsibility for:

- reviewing this specification and making recommendations to the Chief Asset & Operating Officer;
- making recommendations concerning compliance in respect of this specification;
- approving dispensation from this specification where the risk is considered Low or Medium in accordance with Endeavour Energy's risk management procedures; and
- making nominations of Endeavour Energy's representatives.
- determining the equipment procured complies with the requirements of this specification; and
- checking FAT and site test reports and provide dispensations as necessary for marginal non-compliances.

Engineering Delivery Manager has the authority and responsibility for:

- reviewing all type and routine test reports and alternative proposals submitted for evaluation, and making recommendations to the Head of Asset Planning & Performance;
- clarifying all the technical aspects of this specification to the stakeholders; and
- approving the relevant actions required and outlined in this specification.
- Certifying that the equipment purchased through the tender process complies with the requirements of this specification.

Project Managers have the authority and responsibility for reviewing the equipment supplied to confirm it meets requirement of this specification.

Manufacturers/suppliers have the authority and responsibility for:

- adherence and awareness of their responsibilities under this specification;
- providing suitable training of the contractor/s under their control to safely perform works to this specification
- implementing an effective safety, environmental and quality auditing system is in place; and
- implementing this specification and keeping Endeavour Energy or other responsible equivalent officers informed of any factors that may prevent them from accepting responsibility for its full implementation.

6 Annexure 1 - Specific technical common requirements for post inductive voltage transformers and current transformers

Description	33kV	66kV	132kV
Highest system voltages	36kV	72.5kV	145kV
Rated short time withstand current (rms)	31.5kA	31.5kA	40kA
Rated voltage factor (duration)	1.9 (60sec)	1.9 (60 sec)	1.9 (60sec)
Rated frequency	50Hz	50Hz	50Hz
Lightning impulse withstand voltage peak (8/20µs wave)	170kV	325kV	650kV
Power frequency withstand voltage rms (one minute)	70kV	140kV	275kV
Pollution level	Heavy	Heavy	Heavy
Bushing colour	Light grey – ref T33 to AS2700	Light grey - ref T33 to AS2700	Light grey - ref T33 to AS2700

7 Annexure 2 - Specific additional technical requirements for post inductive voltage transformers

Description	33kV	66kV	132kV
Australian standard specification	AS 61869.3	AS 61869.3	AS 61869.3
Connections (vector group)	YNynyn	YNynyn	YNynyn
Rated primary winding volts (phase-neutral)	33kV/ $\sqrt{3}$	66kV/ $\sqrt{3}$	132kV/ $\sqrt{3}$
Rated secondary winding volts (phase-neutral)	110V/ $\sqrt{3}$	110V/ $\sqrt{3}$	110V/ $\sqrt{3}$
Number of secondary windings	2	2	2
Accuracy class for each secondary winding (metering/protection). Refer to Tables 11 and 12 of AS 6044.2: 2007.	0.2 / 3P	0.2 / 3P	0.2 / 3P
Secondary winding rated burden (output) for each secondary	50VA	100VA	100VA

8 Annexure 3 - Summary of specific requirements for post current transformers

TYPE I: 36kV 2500A, 170kV BIL, 31.5kA/1 sec; 5 core CT

Cores: 1 and 2 Protection, 3 Metering, 4 and 5 Protection

	Ratios	Accuracy classes, burden
Protection cores	2000/1000/500/300:1	0.05 PX 200 ($R_{ct} + 2$) @ 2000:1
Metering cores	2000/1000/800/500:1	0.2, minimum 5VA burden on all ratios
Secondary rated continuous thermal current	2A on all ratios for all cores	

TYPE II: 36kV, 1250A, 170kV BIL, 31.5kA/1 sec; 4 core CT

Cores: 1 and 2 Protection, 3 Metering, 4 Protection

	Ratios	Accuracy classes
Protection cores	1000/800/300:1	0.05 PX 100 ($R_{ct} + 3$) @ 1000:1
Metering cores	1000/500/400:1	0.2, Minimum 5VA burden on all ratios
Secondary rated continuous thermal current	2A on all ratios for all cores	

TYPE III - 36kV, 2000A, 170kV BIL, 31.5kA/1 sec; 5 core CT

Cores: 1 and 2 Protection, 3 Metering, 4 and 5 Protection

	Ratios	Accuracy classes
Protection cores	2000/1000/500/250:5	15VA class 10P 20@500:5
Metering cores	2000/1000/800/500:1	0.2, Minimum 5VA burden on all ratios
Secondary rated continuous thermal current	10A on all ratios for protection cores 2A on all ratios for metering core	

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TYPE IV: 72.5kV 2000A, 325kV BIL, 31.5kA/1 sec; 5 core CT
Cores: 1 and 2 Protection, 3 Metering, 4 and 5 Protection

	Ratios	Accuracy classes
Protection cores	2000/1000/500/300:1	0.05 PX 200 ($R_{ct} + 2$) @ 2000:1
Metering cores	2000/1000/500:1	0.2, Minimum 5VA burden on all ratios
Secondary rated continuous thermal current	2A on all ratios for all cores	

TYPE VI: 145kV 2500A, 650kV BIL, 40kA/1 sec; 6 core CT
Cores: 1 and 2 Protection, 3 and 4 Metering, 5 and 6 Protection

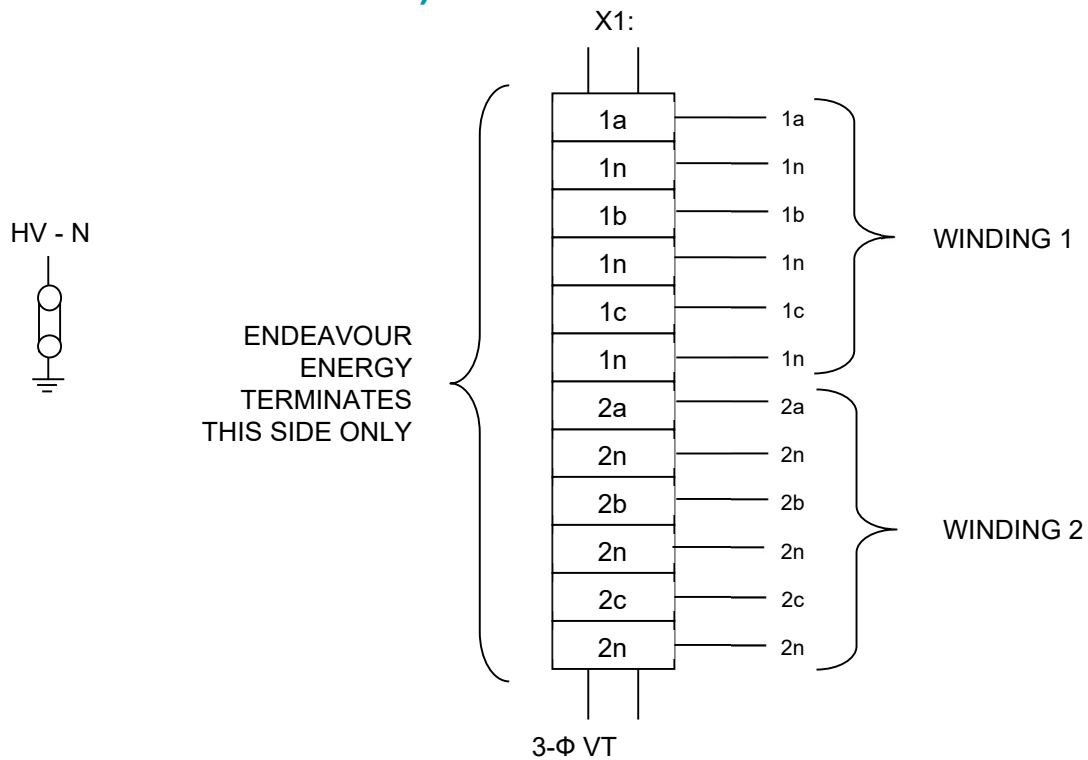
	Ratios	Accuracy classes
Protection cores	2000/1000/500/250:1	0.05 PX 200 ($R_{ct} + 2$) @ 2000:1
Metering cores	2000/1000/800/500:1	0.2, Minimum 5VA burden on all ratios
Secondary rated continuous thermal current	2A on all ratios for all cores	

TYPE VII: 145kV 3150A, 650kV BIL, 40kA/1 sec; 6 core CT
Cores: 1 and 2 Protection, 3 and 4 Metering, 5 and 6 Protection

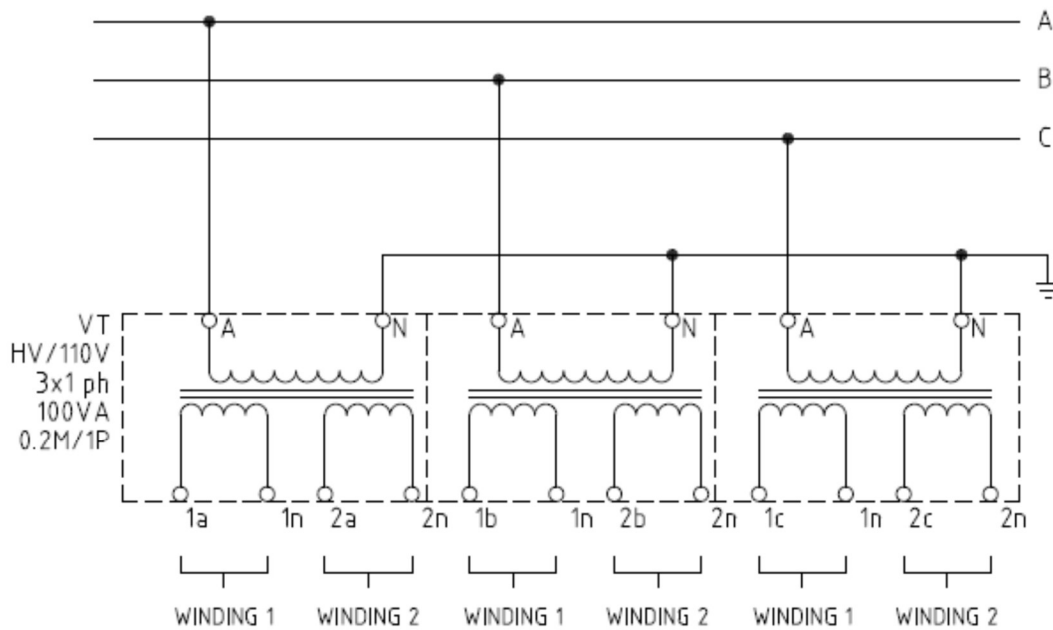
	Ratios	Accuracy classes
Protection Cores	3000/2000/500:1	0.05 PX 300 ($R_{ct} + 2$) @ 2000:1
Metering Cores	3000/1500/800/500:1	0.2, Minimum 5VA burden on all ratios
Secondary rated continuous thermal current	2A on all ratios for all cores	

The supplier should nominate the R_{ct} values for all CT's.

9 Annexure 4 – Post VT terminal rail layout (mandatory customer interface)

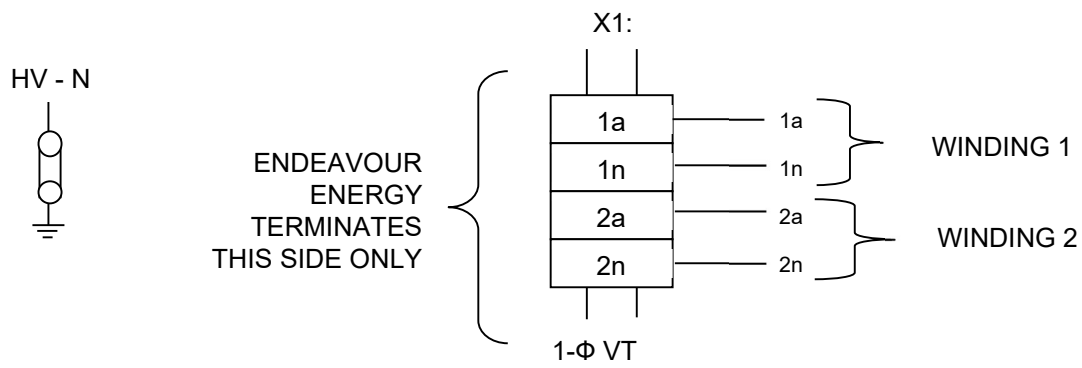


Suitable alternatives will be considered to limit the amount of joints at the discretion of the Engineering Delivery Manager.



Dual winding outdoor 3-Φ VT Circuit and connection diagram

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Produced by Asset Planning and Performance Branch

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