



Specification

Dry Type Cast Resin Transformer 11 kV/433 V for Indoor Substations

Version 1.0

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Standard governance

Owner: Lead Electrical Engineer, Asset Standards Authority
Authoriser: Chief Engineer, Asset Standards Authority
Approver: Executive Director, Asset Standards Authority on behalf of the ASA Configuration Control Board

Document history

Version	Summary of changes
1.0	First issue.

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Preface

The Asset Standards Authority (ASA) is an independent unit within Transport for NSW (TfNSW) and is the network design and standards authority for defined NSW transport assets.

The ASA is responsible for developing engineering governance frameworks to support industry delivery in the assurance of design, safety, integrity, construction, and commissioning of transport assets for the whole asset life cycle. In order to achieve this, the ASA effectively discharges obligations as the authority for various technical, process, and planning matters across the asset life cycle.

The ASA collaborates with industry using stakeholder engagement activities to assist in achieving its mission. These activities help align the ASA to broader government expectations of making it clearer, simpler, and more attractive to do business within the NSW transport industry, allowing the supply chain to deliver safe, efficient, and competent transport services.

The ASA develops, maintains, controls, and publishes a suite of standards and other documentation for transport assets of TfNSW. Further, the ASA ensures that these standards are performance-based to create opportunities for innovation and improve access to a broader competitive supply chain.

This specification sets the performance requirements for the procurement of dry type cast resin 11 kV / 433 V distribution transformers.

This specification has been developed from the RailCorp document EP 16 40 00 01 SP *Dry Type Cast resin Distribution Transformer for Indoor Substations*, version 1.0 and incorporates the contents of TN 082: 2015.

This standard has been approved by the ASA Configuration Control Board (CCB) and is a first issue.

EP 16 40 00 01 SP is withdrawn with the publication of this specification.

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SUPERSEDED

1. Introduction

This document details the whole-of-life performance requirements for the procurement of dry type cast resin 11 kV / 433 V distribution transformers for use in the RailCorp electrical network, installed in indoor substations only.

2. Purpose

The purpose of this document is to specify the requirements for 11 kV / 433 V transformers to enable suitable equipment to be procured for use in the RailCorp electrical network.

TfNSW is focussed on keeping lifetime costs, rather than the procurement cost to a minimum and the features that are specified in this specification that aim to achieve this. To achieve this, equipment that requires the minimum possible maintenance over its life time is preferred.

2.1. Scope

This document provides the specifications for indoor dry type 11 kV / 433 V distribution transformers that are type and routine tested for use in the RailCorp electrical network.

All information required to ensure that the transformers are electrically suitable for use in the RailCorp high voltage network is contained in this document or referenced by this document.

2.2. Application

The requirements of this document apply to all new dry type distribution transformers for indoor use within the RailCorp electrical network. These requirements are applicable from the date of issue of this specification.

This specification is intended to be used by competent personnel engaged in the provision of services relating to railway infrastructure.

The requirements of this document are not applicable to existing 11 kV / 433 V transformers currently in service in the RailCorp electrical network.

Compliance with the requirements in this specification will not, by itself, be sufficient to ensure that satisfactory outcomes will be produced. Personnel providing services based on the specification need to bring appropriate expertise to the matters under consideration. In addition to the requirements of this specification, asset decisions take into account the life cycle cost considerations specified in T MU AM 01001 ST *Life Cycle Costing*.

If, when using this standard, it is considered that the intent of stated requirements is not clear, a clarification should be sought from the Lead Electrical Engineer, ASA.

3. Reference documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian / International Standards

AS 2067 Substations and high voltage installations exceeding 1 kV a.c.

AS/NZS 2344:1997 Limits of electromagnetic interference from overhead a.c. power lines and high voltage equipment installations in the range 0.15 to 1000 MHz

AS 2374.1.2 Power transformers Part 1.2: Minimum Energy Performance Standard (MEPS) requirements for distribution transformers

AS/NZS 60076.1 Power transformers Part 1: General

AS/NZS 60076.3 Power transformers Part 3: Insulation levels, dielectric tests and external clearances in air

AS 60076.4 Power transformers Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors

AS/NZS 60076.5 Power transformers Part 5: Ability to withstand short circuit

AS/NZS 60076.10 Power transformers Part 10: Determination of sound levels

AS/NZS 60076.10.1 Power transformers Part 10.1: Determination of sound levels – Application guide

AS/NZS 60076.11 Power transformers Part 11: Dry – type transformers

AS 62271.301 High voltage switchgear and controlgear Part 301: Dimensional standardization of terminals

Transport for NSW Standards

EP 00 00 00 13 SP Electrical Power Equipment – Design Ranges of Ambient Conditions

EP 00 00 00 15 SP Common Requirements for Electrical Power Equipment

EP 02 00 00 01 SP Transformer Loss Evaluation

EP 19 00 00 02 SP Protection System Requirements for the High Voltage Network

T HR EL 00002 PR Electrical Power Equipment – Integrated Support Requirements

T MU AM 01001 ST Life Cycle Costing

T MU AM 01002 MA Maintenance Requirements Analysis Manual

T MU HF 00001 ST Human Factors Integration – General requirements

T MU MD 00006 ST Engineering Drawings and CAD Requirements

TN 050: 2014 Electrical Type Approvals – Interim process

Legislation

Work Health and Safety Act 2011

4. Terms and definitions

For the purpose of this document, the definitions given in AS 60076 apply. In addition, the following definitions also apply:

AEO Authorised Engineering Organisation

ASA Asset Standards Authority

distribution transformer a transformer that transforms and controls the system voltages to a secondary voltage of nominally 433 V ac (415 V nominal), 240 V ac or 120 V ac

CT current transformer

dry-type transformer a transformer of which the magnetic circuit and windings are not immersed in an insulating liquid

HV winding the winding having the highest rated voltage

IP ingress protection

LV low voltage; voltage exceeding 50 V ac or 120 V ripple-free dc but not exceeding 1000 V ac or 1500 V dc

LV winding the winding having the lowest rated voltage

principal tapping the tapping to which the rated quantities are related

RailCorp NSW Government's asset holding entity for the metropolitan heavy rail network assets. RailCorp infrastructure includes rail infrastructure associated with the metropolitan heavy rail network and excludes rail infrastructure that belong to the Sydney metro and light rail networks.

RFT request for tender

SCADA supervisory control and data acquisition system

SME subject matter expert

TfNSW Transport for NSW

5. Statutory requirements

All works shall consider the requirements of *Work Health and Safety Act 2011*. This act covers the design, installation, operation and removal of equipment as detailed in this specification and shall be documented accordingly.

6. ASA type approval

Transformers procured in accordance with this specification require type approval by the ASA prior to being connected to the RailCorp electrical network.

The current ASA process for type approval at the time of publication of this document is TN 050: 2014 *Electrical Type Approvals – Interim process*.

7. Functional requirements of transformer

The transformer shall provide for the following:

- transformation of system voltage from 11 kV to 433 V
- monitoring of the transformer winding hot spot temperature
- connection of 11 kV and 433 V cables to the associated high voltage switchgear and low voltage switchgear
- connection of supervisory control and data acquisition system (SCADA) auxiliary cabling (to the winding temperature monitor)
- suitable for operation in an environment with conditions as prescribed in this specification

The transformers covered by this specification shall supply railway stations, signals, control rooms, workshops, traction substation and sectioning hut auxiliary supplies and various other low voltage loads. They shall not be used for supplying dc traction loads.

8. Performance characteristics

Where not specifically detailed in this document, the performance characteristics of the transformer shall be in accordance with AS/NZS 60076 *Power Transformers* (all parts).

Table 1 provides details of general requirements of the transformer.

Table 1 – Transformer general requirements

Parameter	Designation
General	<ul style="list-style-type: none"> • indoor, dry type (cast resin) • separate winding • three phase unit
Type of winding	Foil (layer windings are not acceptable)
Type of cooling	AN
Ingress protection (IP) rating	IP21

Table 2 provides the technical specification for the 11 kV / 433 V transformers.

Table 2 – Transformer technical ratings

Technical parameter	Rating
Rated voltage – high voltage (HV)	11 kV (rms)
Rated voltage – low voltage (LV)	433V (rms)
System highest voltage - HV	12 kV (rms)
System highest voltage - LV	1.1 kV (rms)
Connection symbol	Dyn1
Rated insulation level - HV – lightning impulse	95 kV (peak)
Rated insulation level - HV – power frequency	28 kV (rms)
Rated insulation level - LV – lightning impulse	N/A
Rated insulation level - LV – power frequency	5 kV (rms)
Rated frequency (f _r)	50 Hz
Rated power	3 phase: 75, 200, 500, 1000, 1500, 2000, 2500 kVA
Method of neutral earthing of the system	Non-effectively earthed and earthed
Impedance	4% for up to 500 kVA 5% for 1000 kVA 6% for 1500, 2000 and 2500 kVA
Taps, on HV windings through externally operated off-circuit switches, capable of being locked in position	Steps of 2.5% and range of ± 5%
Neutral terminal	Star point or neutral of LV winding shall be connected to a bushing or terminal and fully insulated from earth. The neutral terminal shall be sized to be capable of carrying the same current as the phase terminals.
Partial discharge level	≤ 10 pC in accordance with AS 60076.11
Insulation class	F 155°C
Environment class	E1
Climatic class	C1
Fire behaviour class	F1
Sound power level	Refer to AS 60076.10 <i>Power transformers, Part 10: Determination of sound levels</i>
Ambient temperature range	Refer to EP 00 00 00 13 SP <i>Electrical Power Equipment – Design Ranges of Ambient Conditions</i>

Minimum energy performance standard

The distribution transformer shall meet the minimum power requirements for transformer efficiency at 50% load as specified in AS 2374.1.2 *Power transformers Part 1.2: Minimum Energy Performance Standard (MEPS) requirements for distribution transformers*.

Table 3 provides the power efficiency levels for standard size transformers in accordance with AS 2374.1.2. They only apply to transformers on the 11 kV network.

Table 3 Transformer power efficiency requirements

Transformer power rating	Power efficiency at 50% load
500 kVA	98.84%
1000 kVA	99.03%
1500 kVA	99.12%
2000 kVA	99.16%
2500 kVA	99.19%

9. Technical characteristics

All equipment supplied shall withstand normal handling during transportation and installation, provide continuous operation under the conditions specified in this specification and be suitable for the required duty.

9.1. Construction

The transformer shall be designed to withstand indoor environments where it can be dusty and moist.

All live and exposed parts of the transformer shall have suitable mechanical strength to ensure that mechanical stresses from inrush and short circuit currents and the like do not cause undue deterioration or failure of the transformer. The transformer frame should be constructed from material suitable to last the full life of the transformer and treated such that no maintenance is required.

A minimum IP21 enclosure shall be provided for the transformer in accordance with EP 00 00 00 13 SP. The enclosure shall allow access to the transformer and all associated fittings, terminals and tapping links for maintenance either through lift off lockable doors, hatches or covers removable with the aid of tools. The enclosure shall be removable without the need for disconnection of bushings or terminals from the transformer or removal of any temperature protection equipment. The enclosure shall be constructed such that all ventilation and entry points to the enclosure are vermin proof.

Where there are removable covers, suitable danger signs shall be fixed indicating DANGER HIGH VOLTAGE that is compliant with AS 1319.

9.2. Limiting dimensions

If there are any site specific limiting dimensions these shall be supplied in the request for tender (RFT).

9.3. Rating plate

A rating plate made of pacified stainless steel in accordance with the requirements of AS 60076.1 *Power Transformers, Part 1: General* shall be firmly attached by screws at each corner to a bracket, externally on the transformer enclosure. The plate shall not be attached to any removable cover.

In addition to the requirements of AS 60076.1 the rating plate shall also include the following:

- a diagram of connections
- the TfNSW specification number and version

The rating plate shall be located so that it can be easily read from ground level with the naked eye from the expected viewing distance.

A terminal marking plate complying with the requirements of Section ZB7 of AS 60076.1 shall also be attached to the transformer.

9.4. Terminal arrangement

The HV and LV winding terminals shall be located on opposite sides of the transformer frame. The arrangement for both sets of terminals shall be A, B and C phases from left to right when viewed from the HV side. The neutral terminal shall be on the extreme left (of A phase) unless otherwise agreed by the ASA.

Generally the cables shall enter from below; however provision shall be made for either top or bottom entry of both HV and LV cables with suitable non-magnetic gland plates that can be drilled to suit appropriate cable glands.

For connections using lugs or terminals that are not insulated to the appropriate voltage, the minimum clearances in accordance with AS 2067 *Substations and high voltage installations exceeding 1 kV ac* shall apply. The distance between LV terminals should be appropriate for the number and size of cables connected.

The standard terminal dimensions shall comply with AS 62271.301 *High voltage switchgear and controlgear Part 301: Dimensional standardization of terminals* for accommodation of individual cables.

HV cable terminals for receiving of HV cables shall be sized suitably to allow successful termination with RailCorp cables without further modifications.

LV terminal palms for receiving of LV cables shall be suitably sized to allow successful termination without further modifications and provide for two M12 bolts per cable lug. Low voltage bus-duct may be considered for the 1500 kVA, 2000 kVA and 2500 kVA transformers depending on the site conditions.

Cable quantities and sizes or provision of low voltage bus-duct shall be determined and advised for the particular site application and advised in the RFT.

Cable support clamps shall be provided to support both external HV cables and LV cables so that there is no unnecessary stress on the cable terminal connectors.

9.5. Earth terminal

Two earthing tabs (stainless steel 316) with 2 mm x 14 mm diameter holes suitable for connection of 2 x M12 bolts shall be located externally at diagonally opposite sides, near the bottom of the transformer enclosure for connection to the substation earth grid.

9.6. Lifting attachments

Suitable lifting lugs shall be provided for lifting the transformer (with and without enclosure) and for securing to vehicles during transport using standard slings. Suitable base channels or brackets for insertion of forks from fork lift trucks shall be provided to allow the transformer to be lifted. Brackets, if provided, shall not be less than 200 mm from the ground.

9.7. Transformer manoeuvrability

The transformer shall be fitted with removable bi-directional rollers for future relocations. The rollers shall be lockable to prevent unwanted movement.

9.8. Anti-vibration

Anti-vibration pads shall be supplied for installation under the transformer.

9.9. Temperature protection

Transformers shall be provided with thermal protection through a combination of PT100 sensors and an electronic relay to display temperature digitally in real time of the hottest spot in each winding per phase. The electronic relay shall also provide alarm and tripping functions and be mounted external to the transformer enclosure at a height for easy reading. The relay shall be powered from substation auxiliary supply. It shall be protected from over voltages with a manufacturer's recommended surge limiter and high rupturing capacity (HRC) fuse. The relay shall provide an alarm contact and trip contact. The contacts shall be suitable for connection to a SCADA system operating at either 48 V dc or 125 V dc unless specified otherwise. The alarm

contact shall be set at 10 °C less than the maximum allowable insulation system temperature and the trip contact set at 5 °C less than the maximum allowable insulation system.

9.10. Current transformers

Transformers with a power rating of 1000 kVA and greater are required to be protected by a differential protection scheme. A current transformer (CT) may be required to be installed on each phase of the 415V terminals for implementation of this scheme.

Where CTs are fitted the secondary leads shall be terminated in a marshalling cubicle and CT test links provided as specified in EP 19 00 00 02 SP *Protection System Requirements for the High Voltage Network*.

The requirement and specification for current transformers will be nominated in the RFT.

9.11. Directly earthed neutral terminal

The manufacturer shall be made aware that the secondary side neutral terminal of the distribution transformer is separately earthed within RailCorp's modified directly earthed distribution system under normal service conditions. The source power transformer may not be effectively earthed at the system substation so that over voltages due to the capacitances between windings and between windings and earth can be allowed for in the transformer design.

9.12. Finish

All internal and external surfaces shall be treated with a coating that provides protection against corrosion caused by water such as hot dipped galvanising.

All welds shall be made smooth, rough edges rounded and weld splatter removed. The transformer shall remain corrosion free for the life of the transformer. The internal and external surfaces shall be prepared and the paint applied strictly in accordance with the manufacturer's instructions.

When an existing transformer suffers damage to its finish, the repair shall be done to the original standard of finish.

9.13. Painting

The external surfaces of the transformer shall be painted in accordance with EP 00 00 00 15 SP *Common Requirements for Electrical Power Equipment*.

Any deviation from these requirements shall be subject to ASA type approval.

9.14. Marking

Marking and labelling of the transformer shall be in accordance with the requirements of EP 00 00 00 15 SP.

9.15. Radio interference

The transformer shall comply with the limits of radio interference above 30 MHz as specified in Table B1 of AS/NZS 2344:1997 *Limits of electromagnetic interference from overhead a.c. power lines and high voltage equipment installations in the range 0.15 to 1000 MHz*.

For a 11 kV system voltage the interference limit is 17 $\mu\text{V/m}$.

10. Tests

All tests conducted shall be carried out in accordance with a prepared test program. This program shall detail the sequence of tests.

The transformer shall be completely assembled in the factory. TfNSW reserves the right to witness any of the tests. The manufacturer shall provide a notice to TfNSW six weeks prior to the test commencement date.

All test results including the routine test results of bushings shall be included in the maintenance manuals.

10.1. Type tests

Type tests as stated in AS/NZS 60076.1 *Power transformers Part 1: General* and AS/NZS 60076.11 *Power transformers Part 11: Dry – type transformers* shall be carried out on one transformer of a batch. Type test certificates for each of these tests shall be accepted if it can be demonstrated that the transformer supplied is of a similar design to a previously type tested transformer.

The following additional tests shall be carried out on each transformer:

- Lightning impulse voltage withstand tests including chopped wave tests on maximum tap, mid tap and minimum tap positions for the three phases respectively.
- Sound power level tests shall be conducted in accordance with AS 60076.10. Sound pressure check readings shall be carried out at full rated output during load loss testing and shall be included in the determination of the sound power level in accordance with AS 60076.10.

A short circuit withstand test is not required; however the manufacturer is required to provide the short circuit design calculations.

10.2. Routine tests

Routine tests as stated in AS/NZS 60076.1 and AS/NZS 60076.11 shall be carried out on each transformer, including but not limited to the following:

- winding resistance
- voltage ratio and phase displacement
- short-circuit impedance and load loss
- no-load loss and current
- dielectric routine tests in accordance with AS 60076.3 *Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air*

11. Loss capitalisation

The transformer loss capitalisation shall be evaluated in accordance with EP 02 00 00 01 SP *Transformer Loss Evaluation*.

12. Human factors

The transformers shall be designed in accordance with the human factors principles outlined in T MU HF 00001 ST *Human Factors Integration – General Requirements*.

The design of the transformer shall allow for good access and visibility to items that require access for operation and maintenance. The design shall consider the following:

- location and height of temperature monitor and current transformer connection enclosure
- location, visibility and legibility of signage
- location and visibility of temperature indicators (shall be visible from ground level)

13. Data set associated with the equipment

The following data shall be supplied by the manufacturer and maintained for the transformer:

- information and drawings - all drawings shall conform to the requirements of the T MU MD 00006 ST *Engineering Drawings and CAD Requirements*
- technical schedule - the manufacturer shall supply the information listed in Appendix C, for each transformer

The AEO shall review each item in the technical schedule for compliance with the requirements in this standard and referenced standards where applicable. The engineering assurance report with the AEO recommendations shall be submitted to the Lead Electrical Engineer, ASA.

- test results

This data shall remain the property of TfNSW. Appendix B provides further detail.

14. Integrated system support requirements

TfNSW has specific integrated system support requirements which ensure that operational and maintenance related activities for the life of the equipment being supplied are met.

The manufacturer of the transformer shall establish and provide the information required to operate and maintain the equipment throughout its operational life, in a cost effective manner and to a level that is consistent with the planned operational performance and usage of the transformer.

The manufacturer shall provide the following information:

- specifying maintenance requirements
- spares support
- operations and maintenance manuals
- training
- support equipment and tooling

14.1. Equipment supplier deliverable

The integrated support requirements are a significant deliverable in the procurement of new transformers. Manuals, training, documentation and other support deliverables shall be provided in accordance with T HR EL 00002 PR *Electrical Power Equipment – Integrated Support Requirements*.

14.2. Operation and maintenance manual

An operation and maintenance manual shall be provided for the equipment in accordance with the requirements of T HR EL 00002 PR. The requirements for the scope of operations and maintenance manual are detailed in T HR EL 00002 PR with additional content and emphasis required for photographs to be included from the manufacturing of transformer showing the winding and core.

15. Transformer reliability data

The transformer reliability data is required to be submitted. Refer to T MU AM 01002 MA *Maintenance Requirements Analysis Manual* for further details of TfNSW requirements.

T MU AM 01002 MA supports the *TfNSW Asset Management Policy* with detailed processes for undertaking a maintenance requirement analysis.

The manufacturer shall supply the information listed in Appendix C at the time of tender.

16. Delivery

The transformers that are supplied in accordance with this specification shall be delivered or unloaded at the site or sites nominated in the RFT.

Vibration and impact or shock data recorders shall be fitted to the transformer or transformers during transport to ensure vibration, accelerations and frequencies are maintained within acceptable limits and no damage is caused. The manufacturer shall analyse the data recorders and provide a report to the AEO for review. The AEO shall submit the report to the Lead Electrical Engineer, ASA with its recommendations.

Lifting and slinging instructions shall be provided for unloading and moving the transformers at site.

Appendix A Whole-of-life cost

This appendix is provided for use by the AEO in assessing the whole-of-life cost of the transformer.

The selection of the most suitable transformer design should be made on the basis of minimising the whole-of-life cost. The following factors should be considered in determining this:

- cost of changes to the technical maintenance plan and service schedules or the creation of new manuals and schedules
- cost of decommissioning and disposal
- cost of installation
- cost of inventory spares
- cost of maintenance
- cost of modifications to other parts of the installation
- cost of replacement parts
- cost of special tools
- cost of staff training
- discount rate (example, for multiple units)
- electrical losses
- environmental costs
- initial purchase price
- lifetime of equipment
- reliability and cost of consequential damage after failure
- cost of optional tests

If this transformer has not previously been type approved by the ASA in accordance with TN 050: 2014, then the costs for this process should be included in the whole-of-life cost.

Appendix B Data set associated with the equipment

Section B.1, Section B.2, Section B.3 and Section B.4 provide details of the data that is supplied by the manufacturer and maintained for the transformer. This data will remain the property of TfNSW.

B.1. Drawings and information

The following is the minimum set of drawings and attributes that should be included in the drawings:

- transformer arrangement drawings are drawn to scale with the following details:
 - complete detail of the transformer with complete views of all sides of the transformer and detailed sections as required
 - dimensions, including overall size, position of HV and LV connectors relative to the centre lines of the tank and the level of the foundations
 - mass of the complete transformer, mass of the core and windings and mass of the enclosure (where it can be removed)
 - complete listing of all fittings, accessories and parts with the associated manufacturer, part or model number and relevant ratings

- schematic and wiring diagrams

Schematic diagrams should include the following:

- schematic diagrams of the transformer windings showing connections, tappings and tabulations of current and voltage rating of all windings
- schematic diagram of alarm and trip circuits
- details shown on the rating plate drawings should match the plates fixed to the transformer
- drawings of any special slinging arrangement required for handling the transformer during shipment or erection

All the drawings should contain the plant serial numbers of all units.

Note: This list does not include component drawings which are required as part of the integrated support requirements and are included in the operations and maintenance manual.

The calculation of inrush current is required.

B.2. Technical schedule

The information listed in the technical schedule of Appendix C should be completed by the manufacturer and engineering assurance provided by the AEO for each transformer.

B.3. Life cycle costing

All the data and assumptions pertaining to the determination of the whole-of-life cost calculations of the transformer should be recorded by the AEO including the transformer loss calculations as detailed in EP 02 00 00 01 SP.

B.4. Test results

The results of all tests relating to the transformer including acceptance tests and periodic and corrective maintenance tests should be recorded.

Routine test certificate and type test certificate showing the results of each test performed should be supplied in searchable PDF format, in English, and maintained for the life of the transformer.

Appendix C Technical schedule

The information listed in this technical schedule is provided by the manufacturer with the tender for each transformer.

Transformer details:	
Name of manufacturer	
Country of manufacture	
Rated HV voltage	V
Rated LV voltage	V
Rated power	MVA
Rated HV current	A
Rated LV current	A
Rated frequency	Hz
Efficiency at 50% load (MEPS requirement)	%
Connection symbol	
No-load current with rated voltage applied to the principal tapping	%
No-load current with 110% rated voltage applied to the principal tapping	A
Short circuit capability (current & duration)	A for s
No-load loss	W
Load loss at 75 °C	W
Inrush current	A
Thermal time constant – winding	Mins
Impedance voltage at rated current and 75°C	%
Maximum temperature rise of winding	°C
Sound power level	dB(A)
Construction details:	
IP rating	
Type of core steel - hot or cold rolled	
Brand or trade name and grade of core steel	
Maximum flux density on net cross-section of steel with rated volts at rated frequency applied to the centre tapping	
Limbs	T
Yoke	T
Material used for HV winding	

Material used for LV winding	
Class of insulation on windings	
Environment class	
Climate class	
Fire behaviour class	
Locking mechanism applied to all internal bolts	Yes/No
Type of Locking mechanism used on internal bolts	
Protective treatment applied to transformer enclosure	
Internal surfaces	
External surfaces	
Transformer dimensions:	
Overall dimensions (with enclosure fitted)	
Length	mm
Width	mm
Height	mm
Overall dimensions of enclosure	
Length	mm
Width	mm
Height	mm
Terminal clearances in air:	
HV – between phases	mm
LV – between phases	mm
HV – phase to earth	mm
LV – phase to earth	mm
Terminal palms – please provide drawing detailing the palm dimensions.	
Transformer mass:	
Mass of complete transformer	kg
Mass of transformer core and windings only	kg
Mass of windings only	kg
Mass of transformer enclosure	kg

11 kV bushing details (where applicable):	
Manufacturer	
Manufacturer's type number	

Insulator material	
Continuous current rating	A
Lightning impulse flashover	kVp
Creepage distance	mm
Minimum air clearance between phases	mm
Minimum air clearance phase to earth	mm
Palm dimensions	mm x mm

433 kV bushing details (where applicable):	
Manufacturer	
Manufacturer's type number	
Insulator material	
Continuous current rating	A
Lightning impulse flashover	kVp
Creepage distance	mm
Minimum air clearance between phases	mm
Minimum air clearance phase to earth	mm
Palm dimensions	mm x mm

Miscellaneous equipment:	Manufacturer	Model number
Winding temperature indicator		
Temperature probe		
Current transformers		
Resin - Fire Properties		
As these transformers are located in critical fire and life safety substations the manufacturer is to provide detail on the flammability and toxicity of the resin used for the transformer insulation.		

Transformer reliability data (use separate sheet if necessary):	
Design life	Years
Failure modes (for early, normal life and wear out periods):	a)
	b)
	c)
Mean operating hours between failures:	a)

	b)
	c)
Time to repair:	a)
	b)
	c)

C.1. Drawings and information to be submitted with the tender

In addition to the technical schedule, the following information should be submitted with the tender:

- Outline drawings - Fully dimensioned outline drawings showing all fittings, terminal arrangements. The general arrangements and layouts should reflect the final design unless written approval is obtained from TfNSW.
- Core material characteristics - Typical curves of flux density versus ampere turns per metre for the core material.
- Core information - Detailed description of the core type, methods of making joints, insulation between laminations, treatment of edges, core bolt insulation and method for minimising hot spots in limbs. Include details of the proposed method for verifying core hot spot temperature and method for how the core is earthed.
- Details of manufacturers' quality management system.
- Reference list where similar equipment has been installed and is under satisfactory operation for the past two years as a minimum.
- Temperature indicator - A full description of temperature indicator including detailed design information and location of probe.
- Other information - Any other information considered necessary by the manufacturer.
- Features of the transformer design - Provide details of the transformer design. This should include a description of the following:
 - the overall transformer design
 - the method for modelling the design electrically, thermally and structurally
 - lessons learnt from previous similar designs and how this has been addressed in this design
 - quality processes during design and manufacture to ensure the design meets TfNSW standards and appropriate Australian and international standards and information that demonstrates the manufacture of the transformer in accordance with the design

- departures from standard – provide details of any departures from the requirements of this specification on a separate sheet
- special delivery requirements - any special requirements that are envisaged for the safe delivery of the transformer to the specified site should be stated at tender stage

SUPERSEDED

Appendix D Information requirements for the RFT

This appendix provides a summary of the information requirements for the RFT. The information includes both technical details in Table 4 and site specific information in Table 5.

Table 4 – Technical details to include in the RFT

Transformer item	Technical details to include in the RFT
Transformer rated power	Indicate the required rated power in accordance with standard sizes in accordance with Table 2.
Bus duct or cable termination	Indicate whether the connection to the LV is by bus duct or cable and include corresponding quantities and dimensions.
Current transformers	Indicate whether current transformers are required for differential protection on the 415 V terminals

Table 5 – Site specific information to consider including in the RFT

Site specific information	Information to include in the RFT
Site specific limitations on size or arrangement	Indicate whether there are size limitations imposed by surrounding infrastructure
Access and transportation limits	Access road weight limit Maximum road width Maximum standard height above road
Access road alongside operating railway	Provide details of whether or not the access road to the site is within the rail corridor and adjacent to an operating railway track