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- ETS 0066 Pole
- substation distribution
- transformers

ETS 0066

Amendment No 2
20 June 2019

Revision History

This specification replaces amendment no 1 of ETS 0066 – Pole substation distribution transformers. All changes are highlighted in this document with grey colouring.

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Contact Information

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<http://www.endeavourenergy.com.au/aspPortal/webengine/au/com/ee/asp/Standards/Standards>.

For any enquiries relating to the content of this document please contact the Standards Coordinator on 13 10 81.

Document Control

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1 Documentation Scope

This Specification covers the design, engineering, manufacture, testing, supply and delivery of 11kV, 22kV and 12.7kV SWER pole substation distribution transformers, up to and including 400kVA.

It is not the intention to specify all design and fabrication details of the distribution transformers; however, the equipment supplied shall meet the highest standards of design, engineering and manufacturing practices.

All supplied transformers and associated equipment shall be manufactured and tested to the standards with the year of publication listed in 2.0 below. In some circumstances based on local network conditions and experience, this specification is more stringent or is inclusive of requirement not covered in Australian and International standards; in this circumstance the requirements of this specification shall take precedence.

The tenderer shall state any non-compliance with the specification in the tender submission and any alternative offers should be submitted in full and separately from the main offer. Any proposed variations from this specification shall be referred to Substation Assets Manager for approval prior to acceptance.

2 References

External Regulations

Electricity Supply Act 1995 (as amended)

Greenhouse and Energy Minimum Standards (GEMS) Act 2012

Work Health and Safety Act 2011 (NSW)

ENA Doc 001-2008 National Electricity Network Safety Code

ENA Doc 007-2006 Specifications for Polemounting distribution transformers

Drawing no's TX-1, TX-2, TX3, TX-4 - attachments to ENA DOC-007-2006

External Standards

AS 1111:2015 - ISO Metric Hexagon Bolts and Screws parts 1 and 2

AS 1112:2015 - ISO Metric Nuts including Thin Nuts, Slotted Nuts and Castle Nuts part 1 to 4

AS 1194:1996 - Winding Wires Parts 1 - 4

AS 1214:1983 - Hot dipped galvanised coatings on threaded fasteners (ISO metric coarse thread series)

AS 1580:2004 - Paints and related materials – Methods of test – Introduction and list of methods

AS 1627:1997(R2017) - Metal finishing - Preparation and Pretreatment of Surfaces

AS 2067:2016 - Substations and high voltage installations exceeding 1kV a.c

AS 2374.1.2:2003 (R2016) - Power transformers - Minimum Energy Performance Standard (MEPS) requirements for distribution transformers

AS 2374.8:2000 - Power transformers Part 8: Application guide

External Standards

AS 2700S:2011 (N42) - Colour Standards for general purposes – Storm Grey
AS 2700S:2011 (G62) - Colour Standards for general purposes – Rivergum
AS 4398.1:1996(R2016) – Insulators - Ceramic and Glass - Station post for indoor and outdoor use greater than 1000 V ac - Characteristics
AS 4398.2:2005(R2016) – Insulators - Ceramic and Glass - Station post for indoor and outdoor use greater than 1000 V ac - Tests
AS 4436:1996(R2016) – Guide for the selection of insulators in respect of polluted conditions
AS/NZS 60076.1:2014 - Power transformers: General
AS/NZS 60076.2:2013 – Power transformers – Temperature rise for liquid immersed transformers
AS/NZS 2312:2014 - Guide to protection of iron and steel against exterior atmospheric corrosion by the use of protective coatings
AS/NZS 2344:2016– Limits of electromagnetic interference from overhead ac powerlines and high voltage equipment installations in the frequency range 0.15 to 3000MHz
AS/NZS 3750:2008 - Paints for steel structures
AS/NZS 4680:2006(R2017) - Hot dipped galvanised (zinc) coatings on fabricated ferrous articles
AS/NZS 60076.3:2017 - Power transformers Part 3: Insulation levels, dielectric tests and external clearances in air
AS 60076.4:2006(R2016) - Power transformers - Guide to the lightning impulse and switching impulse testing: Power transformers and reactors
AS/NZS 60076.5:2012 - Power transformers – Ability to withstand short circuit
AS/NZS 60076.7:2013 - Power transformers – Loading guide for oil immersed power transformers
AS/NZS 60076.10:2009 - Power transformers Part 10: Determination of sound levels
AS/NZS 60076.10.1:2009 - Power transformers Part 10.1: Determination of sound levels - Application guide
AS/NZS 60137:2008 - Insulated Bushings for Alternating Voltages above 1000V
AS 60422:2017 – Mineral insulating oils in electrical equipment
IEC 60216:2001 - Electrical insulating materials
IEC 62770:2013 – Fluids for electrotechnical applications – Unused natural esters for transformers and similar electrical equipment
AS/NZS ISO 9000:2016 - Quality management systems

Company Policies and Procedures

Company Policy 9.2.5 – Network Asset Design
Company Policy 9.7.1 – Network Asset Construction
Company Procedure GRM 0003 – Risk Management

Company Policies and Procedures

Company Procedure GSY 0026 – Health, Safety and Environment Risk Management

Company Form FSY 0138 – Risk Register

Environmental Management Standard EMS 0001 – Environmental impact assessment and environmental management plans

Earthing Design Instruction EDI 100 – Distribution earthing design

Equipment Technical Specification ETS 0010 – Mineral Insulating oil

Equipment Technical Specification ETS 0032 – Natural ester insulating oil

Mains Construction Instruction MCI 0005 – Overhead construction standards manual

Mains Design Instruction MDI 0031 – Overhead line design

Substation Design Instruction SDI 120 – Testing and commissioning for distribution systems

Branch Procedure PAE 1004 – Product approval process

Branch Form FAE 3009 – Pole substation distribution transformer Product approval and audit form

Drawing no. 006037, am N - Single pole mounted transformer section showing mounting bracket, Rating plates, Earth stud locations & CT Terminal box

3 Definitions and Abbreviations

Term	Definition
MEPS	Minimum Energy Performance Standard
MSDS	Material Safety Data Sheet
NATA	National Association of Testing Authorities
SWER	single wire earth return
PCB	polychlorinated biphenyls
ppm	parts per million
rms	root mean square
UV	ultra violet
Type tests	A test made on a transformer which is representative of other transformers, to demonstrate that these transformers comply with the specified requirements not covered by the routine tests: a transformer is considered to be representative of others if it is built to the same drawings using the same techniques and materials in the same factory
Routine tests	A test to which each individual transformer is subjected
Special tests	A test other than a type test or a routine test, agreed by the manufacturer and the purchaser

4 Requirements

4.1 General requirements

The 11kV, 22kV and 12.7kV SWER pole substation distribution transformers, up to and including 400kVA will be used in Endeavour Energy's network for replacement and in new installations.

Mains Construction Instruction MCI 0005 – Overhead construction standards manual provides the mandatory construction, operational and material requirements for pole substations for Endeavour Energy's network. The on-site earthing requirements are given in Equipment Technical Specification ETS 0010 – Mineral Insulating oil.

4.1.1 Service conditions

Transformers shall be suitable for use on Endeavour Energy's 11kV or 22kV, 3-phase, 50Hz system. The neutral point of the 11kV system is effectively earthed and the expected highest system voltage in normal operation is 12kV. SWER transformers have network voltages of 12.7kV. The 22kV system neutral point is either non-effectively earthed or effectively earthed, and for the 22kV system the expected highest system voltage in normal operation is 24kV. The transformer insulation at both 12kV and 24kV shall be designed for a non-effectively earthed network.

Service conditions shall be in accordance with the requirements of clause 4 of AS/NZS 60076.1.

4.2 Health, safety and environment (HSE) requirements

4.2.1 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 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. Oil provided shall be polychlorinated biphenyls (PCB) free.

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

4.2.2 Sound levels

Each transformer shall be designed and constructed so that its sound power level, measured in accordance with the AS 60076.10:2009, shall be no greater than the *reduced limit* as set out in clause 4.3 of this specification.

4.2.3 Oil pollution

Joints between oil containing parts of the equipment shall be leak tight and shall be pressure tested. Gasket joints shall be designed to avoid deterioration due to oil or excess strain.

4.2.4 Transformer efficiency

All supplied transformers shall meet the Minimum Energy Performance Standard (MEPS) as detailed in AS 2374.1.2:2003. The manufacturer is required to guarantee that efficiency of the transformer at 50%

load will not be less than that specified in the technical parameter section (refer section 4.3). Transformers that fail to meet this requirement are not acceptable for use in Endeavour Energy's network.

4.2.5 Noise levels and radio interference voltage (RIV)

The pole substation transformer may be installed in a residential area in close proximity to residences. Therefore, it is necessary to ensure the noise level complies with this specification and the radio interference is $17\mu\text{V/m}$ for 11kV and $22\mu\text{V/m}$ for 22kV, as specified in AS/NZS 2344:1997.

4.2.6 Fire and blast hazards

The transformer and its components shall be designed in a manner to reduce the risk of rupture and explosive failure and subsequent fire risk. Means to achieve this should be detailed in the offer.

4.2.7 Safe working at heights

For maintenance requirements, workers will require access to the top of the transformer tank and its ancillaries. Provisions in the design shall be made for a permanent ladder attachment point that will enable employees to have safe access at elevated locations (for instance, to replace surge arrestors). Details of such provisions shall be provided in the tender offer for evaluation and approval of Endeavour Energy.

4.3 Transformer construction

The basic fabrication of the transformer shall conform to Drawing no. 006037, and Drawing no's TX-1, TX-2, TX3, TX-4 - attachments to ENA DOC-007-2006. The transformer shall be designed for an expected life of at least 45 years.

Endeavour Energy due to historical parameters prefers core type transformers with cylindrical concentric coils. However, other designs may be considered provided the mechanical integrity of the coils can be amply demonstrated through test results, especially the short circuit test, set out in clause 4.9.1.

Transformers shall be of sealed tank type construction.

Sealed transformers shall not be pressurised. Diaphragm sealing is not acceptable.

Typically, sealed transformers will be vacuumed and filled with clean dry air. Transformers with bio degradable oil or natural esters, such as *Envirotemp* FR3 fluid, shall be sealed with a suitable gas, such as nitrogen, to fill the void for improved oxidation stability.

The lid of the transformer shall not be welded to the tank: instead it should be affixed with nuts and bolts.

The core shall be bonded to the tank at one point. The facility to disconnect the bond (for testing purposes) through a readily accessible bolt shall also be provided.

A suitable oil level indicator must be provided on all transformers, to ensure that the oil level can be checked with the transformer in its service position. The gauge shall not discolour due to exposure to sunlight or due to reaction with the insulation oil.

All penetrations of the tank shall be above the oil level in the transformer. The filler cap shall be a minimum of 25NB and allow a pipe to drop to the base of the tank for oil sampling.

All low voltage neutral terminal lug shall be fitted with double hole lug.

All component parts shall be supplied and tested in accordance with the appropriate Australian Standard.

The transformer shall include everything necessary or usually supplied for the operation, whether directly specified or not.

4.4 Technical requirements

4.4.1 Transformer

Transformers shall technically comply with Energy Network Association (ENA) Doc 007-2006 except where indicated in this specification. Attachment C of the ENA specification provides six (6) options for the design of transformers. Endeavour Energy prefers these options with the conditions stated below:

Option 1: All transformers shall be supplied with extra HV clearances from the pole face to the HV terminal palm, as indicated in the ENA specification.

Alternatively, Endeavour Energy may accept a safety barrier with standard HV clearance. The safety barrier shall be independently removable and shall be designed to comply with Figure 1 below. The barrier design shall be subject to approval.

Option 2: A mounting bracket, similar to that shown in Drawing no. 006037, shall be provided for all transformers rated at 100kVA and above. A clear space of 115mm is required behind the transformer for the installation of a 100mm crossarm.

Transformers with smaller ratings (63kVA and below) shall be pole-bolt mounted, as set out in the drawing TX-2 in the ENA specification, with Z dimension 500mm.

Option 3: Heavy-duty protective paint coating is not required.

Option 4: Pressure test on sealed transformers is required.

Option 5: Provision for platform mounting is not required.

Option 6: Reduced phase to phase clearances are not acceptable.

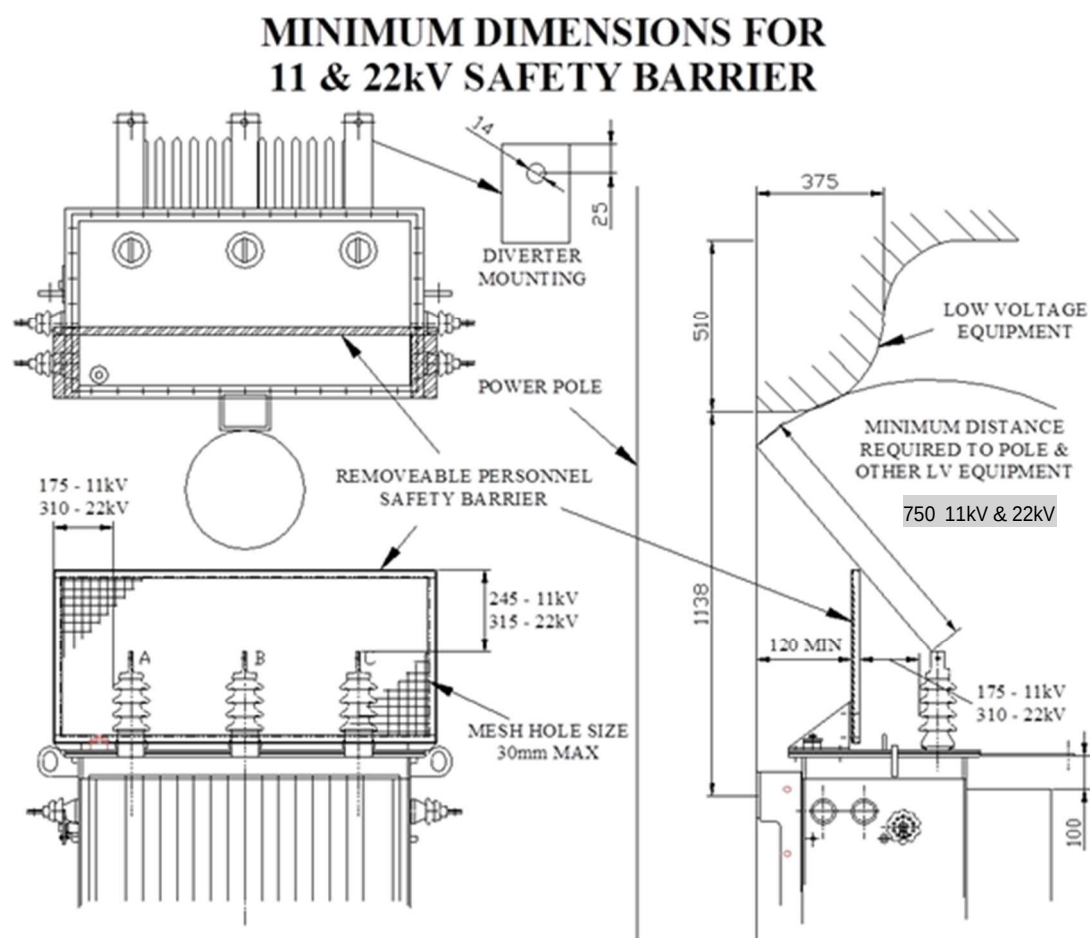


Fig. 1 Minimum dimensions for 11 & 22kV safety barrier

4.5 Technical particulars

This Specification includes transformers of the following types and ratings:

Description		
Transformer type	11	22
System voltage three phase (kV rms)	12	24
Power frequency withstand HV	28 kV rms for one (1) minute	50 kV rms for one (1) minute

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Description		
Lightning impulse withstand HV	75 kVp 1.2/50µs wave ¹	125 kVp 1.2/50µs wave
Power frequency withstand LV to Earth	10 kV rms for one (1) minute	
Mineral insulating oil (where used)	Inhibited mineral oil in accordance with AS 60422:2017	
K class Natural ester oil (where used)	Envirotemp FR3 fluid (or other equivalent that complies to IEC 62770: 2013 and ETS 0032)	
Transformer type	Two winding/phase	
Maximum sound power level	56dBA	
System short circuit current	16kA/1 second for both 11kV and 22kV	
Maximum lift weight (complete with oil)	As per ENA Doc 007 ≤2000kg	
Temperature rise limits (mineral oil – where used)	Average winding 65°C Top oil 60°C	
Temperature rise limits (K class natural ester oil – where used)	Average winding 75°C Top oil 90°C	
Impedance voltage at rated current on principal tapping	3.3% for 25, 50 and 63kVA 4.0% for 100, 200, 315 and 400kVA (complies to ENA Doc 007)	
Tapping	Off circuit on HV windings	
Tapping range	+5% to –5% of rated voltage in 5 x 2.5% equal steps	
Three phase transformers		
Vector group	Dyn11	
Voltage ratio	11,000/433 Volts	22,000/433 Volts
Rated power	25, 63, 100, 200, 315 and 400kVA	
Single phase transformers		
Voltage ratio	11,000 (ph-ph) /250 – 500 Volts	22,000 (ph-ph) /250 – 500 Volts
Rated power	25 and 50kVA	
SWER transformers		
Voltage ratio	12,700/250 – 500 Volts	

¹ 75kVp is applicable to designs protected by close surge arresters with low residual voltage. Design elements to reduce the cable lead length between the transformer tank and the surge arrester must be incorporated and detailed in the offer.

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Description						
Rated power	16 and 25kVA					
SWER isolating transformers						
Voltage ratio	11,000/12,700/250 – 500 Volts			22,000/12,700/250 – 500 Volts		
Rated power	100/100/10kVA			100/100/10kVA		
Minimum power efficiency @ 50% load						
Three phase	25kVA	63kVA	100kVA	200kVA	315kVA	400kVA
	98.28%	98.62%	98.76%	98.94%	99.04%	99.08%
Single phase (and SWER)	16kVA	25kVA	50kVA			
	98.52%	98.70%	98.90%			

All other technical particulars, including maximum total mass and dimensional limits of the transformers shall be in accordance with attachment A of ENA Doc 007-2006.

4.6 Drying out and oil filling before delivery

The tenderer must ensure that the transformers are thoroughly dried out at the supplier's works and are delivered filled with oil to the correct level and ready for service.

The tenderer must provide production details of:

- the methods used for drying transformers prior to filling with oil;
- the maximum moisture content of the transformer after drying; and
- the methods used to ensure that the moisture content has been reduced below the maximum moisture level stated above.

The manufacturer shall also provide a detailed procedure of drying transformers and the oil filling process which shall demonstrate that the transformer is in a dry state at the time of filling it with oil. The procedure shall also demonstrate how the moisture content of the oil is less than 10ppm at the time of filling.

4.7 Transformer loss performance acceptance

Where a transformer's load or no load losses exceed the contract guaranteed values by 7.5%, or the transformer's total loss exceeds the guaranteed loss by 5%, Endeavour Energy will not accept the transformer.

4.8 Accessories

The transformers shall be provided with accessories as described in ENA Doc 007-2006. The following are the additional requirements:

4.8.1 Rating plate details

A rating plate shall be provided in accordance with section 5.12.1 of the ENA Specification.

If a separate current transformer rating plate is provided, it shall be located adjacent to the transformer rating plate.

The rating plate shall be located on the middle to lower part of the low voltage end of the tank.

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The rating plate shall state the following additional information:

- Manufacturer's design number.
- Endeavour Energy approval number.
- Endeavour Energy plant number.
- Minimum and maximum withstand pressure (kPa absolute) of the transformer.
- In addition, the following shall be indelibly marked on the transformer tank in 75mm high black letters:
- kVA rating: ---kVA
- Endeavour Energy's plant number: XXXXX
- Filled with insulating fluid: **PCB FREE MINERAL OIL** or **ENVIROTEMP FR3**, whichever is applicable.

4.8.2 Transformer oil

4.8.2.1 Mineral oil

Transformers supplied with mineral based, uninhibited, primarily naphthenic distillate insulating oil shall be free of PCB. The mineral insulating oil shall be in accordance with **Equipment Technical Specification ETS 0010 – Mineral Insulating oil**.

Transformers shall be thoroughly dried out and shall be oil filled under vacuum. The moisture content of the oil at the time of filling shall not be more than 10ppm.

Refer to clause 4.6 for the transformer drying and oil filling requirements.

4.8.2.2 Natural ester oil

Transformers used in sensitive areas (for example, fire risk areas, water catchments) will require natural ester oil due to the biodegradable properties and higher flash point. Where cost effective, natural ester oil transformers will be utilised in the network more widely

At present, Envirotemp FR3 fluid is the Endeavour Energy approved natural ester oil that may be used. Alternative natural ester oils will be considered subject to the approval of the Substations Assets Manager but must comply with the requirements and performance criteria of IEC 62770:2013.

4.8.3 Surface finish

Endeavour Energy requires all internal and external surfaces to be treated with a coating that provides protection against corrosion induced by water, salt-laden atmosphere and industrial pollutants. Finished coatings must be oil resistant, heat resistant and non-corrosive.

The resulting surface coating inside the transformer tank must not react with transformer oil or its additives. All coatings (except the interior surface of the transformer) must be capable of being easily maintained and repaired on-site.

As the expected life of the transformer is in excess of 45 years, the life requirements for the coating system to first maintenance must be classified as very long-term, in accordance with clause 1.6 of AS/NZS 2312:2002. The costs of recoating the transformer during its life will be considered when calculating the transformer's life cycle cost.

Alternative surface coating systems may be considered by Endeavour Energy if full details are provided.

Full details of the protective coating system and its ability to resist corrosion under the specified environmental conditions; taking into account expected surface wear due to usual transportation, lifting and installation procedures (excepting malicious damage), must be given. The supplier must provide details on the method of protective coating repair to allow Endeavour Energy to carry out field maintenance as required.

Details of all tests (such as accelerated ageing, scab corrosion, salt spray, fog, and impact) performed to prove the effectiveness of the proposed protective coating, and how the proposed protective coating compared with other test samples, must be provided.

The final colours of transformers shall be:

- N42 to 2700S:1996 - STORMY GREY for mineral oil filled transformers; and
- G62 to AS 2700S:1996 - RIVERGUM for natural ester oil filled transformers.

4.9 Testing

4.9.1 General

The following clauses set out the testing requirement for transformers.

Endeavour Energy places a very high emphasis on the quality of materials and equipment installed in its network. Any relaxation of these standards by Endeavour Energy or the manufacturer/supplier will be at a heavy cost to the industry.

In order to ascertain and determine that the quality of the products manufactured for Endeavour Energy are to the expected standard or better, Endeavour Energy seeks active cooperation from suppliers/manufacturers of Distribution Transformers by agreeing to following conditions:

1. The manufacturer agrees to visits by Endeavour Energy staff for inspections of the transformer manufacturing process.

To assist with these inspections, the manufacturer shall provide Endeavour Energy with a production schedule indicating the dates when the transformers under a specific contract to Endeavour Energy are being manufactured.

Any supplier intending to supply transformers to this specification shall prepare and submit a complete document with the heading **Testing Code** describing the test methods listed in this document. The document should clearly indicate, with necessary and sufficient sketches, drawings, circuit diagrams, and/or photographs, the equipment used, the test methodology (with relevant theory), and other relevant information.

2. The type tests and special tests specified are to be suitably proven by test or calculation with design and manufacture considerations for all types of transformers. Where type test is required, Endeavour Energy shall be advised of the type test program at least four (4) weeks prior to the tests so that Endeavour Energy personnel can witness the tests. The cost of type tests shall be borne by the manufacturer.
3. Endeavour Energy may conduct type or special tests for a randomly selected sample from each or any type of the supplied transformers at Endeavour Energy's expense, in addition to the type tests conducted by the manufacturer.

The manufacturer will be informed four (4) weeks prior to these tests being conducted so that they can witness the tests if desired. Production schedules shall be provided.

4. In the event that any type or special test conducted by Endeavour Energy fails to conform to specifications, depending on the nature of the failure, Endeavour Energy will, in consultation with the manufacturer, carry out further type tests on one or more transformers of the type at the manufacturer's expense. If the tested transformer fails to meet the acceptable criteria, the cost of tests carried out by Endeavour Energy shall also be borne by the manufacturer.

The outcome of these tests will decide the acceptance of transformers by Endeavour Energy. Costs pertaining to all transactions resulting from these failures shall be borne by the manufacturer.

5. Routine and special tests specified by Endeavour Energy shall be carried out for each transformer, and only those transformers that pass these tests will be accepted
6. Endeavour Energy may conduct tests specified as routine performance or special tests for a randomly selected sample from each or any category of the supplied transformers, at Endeavour Energy's expense.

The manufacturer will be informed four (4) weeks prior to these tests being conducted so that they can witness the tests if desired. Production schedules shall be provided.

7. Any transformer tested according to item 7 that fails to comply with the specifications will be returned to the manufacturer and further similar tests will be conducted on other selected samples, depending on the nature of the failure. This process continues at the manufacturer's expense until such time that Endeavour Energy can ascertain the integrity of the transformers supplied under a specific contract.

The manufacturer shall provide two (2) copies of certified test reports for type, routine and special tests.

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.

Tests from other testing authorities, such as KEMA, may be accepted at the discretion of Substation Assets Manager Endeavour Energy.

Type tests more than five (5) years old may be acceptable at the discretion of the Substation Assets Manager.

All type and routine test costs shall be borne by the manufacturer/supplier.

4.9.2 Type test

The offered types of transformers shall be subjected to the following type tests:

No.	Type test	Acceptable value	Test method reference
1.	Temperature rise test	Section 4.5 of this specification and clause 7 of AS/NZS 60076.2:2013.	Clause 7 of AS/NZS 60076.2:2013

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No.	Type test	Acceptable value	Test method reference
2.	Lightning impulse voltage withstand tests including chopped wave tests.	No disruptive discharge and comparable wave shapes (before / after)	Clauses 13 & 14 of AS/NZS 60076.3:2008
3.	Sound level test	≤ 56dBA	AS 60076.10.1:2009
4.	Short circuit test	Circular concentric coils – reactance change < 2% Metal foil – reactance change < 4% Non-circular concentric coils – reactance change < 7.5%	Clause 4.2.7.4 of AS/NZS 60076.5:2012
5.	Pressure test on sealed transformers	Clause 6.4 of ENA Doc 007:2006	Clause 11.8 of AS/NZS 60076.1:2014
6.	Testing on the protective coating of the tank shall be carried out according to the relevant Australian or International standard.	Manufacturer to verify to Endeavour Energy's satisfaction.	various

4.9.2.1 Special test

The following special tests shall be conducted for on each transformer of each design, size and rating.

No.	Special test	Acceptable value	Test method reference
1.	10kV power frequency withstand test on LV winding	No failure.	Clause 11 of AS/NZS 60076.3:2008
2.	Mass of transformer (complete with oil and current transformer)	Section 4.5 of this specification.	

Endeavour Energy may accept results of previously conducted type tests provided the offered transformers are the same as the type tested transformer, and the type tested transformers are in accordance with this specification.

Where the offered transformers have not been successfully type tested, or the test results do not meet the technical requirements of this specification, fresh type tests shall be conducted at the manufacturer's expense. Endeavour Energy will not purchase or accept any transformer that has undergone short circuit testing.

4.9.3 Routine test

The following routine tests shall be conducted on each transformer supplied to Endeavour Energy:

No.	Routine test	Acceptable value	Test method reference
1.	Measurement of winding resistance	Specified by the manufacturer.	Clause 11.2 of AS/NZS 60076.1:2014
2.	Measurement of voltage ratio and check of phase relationship.	Specified by the manufacturer.	Clause 11.3 of AS/NZS 60076.1:2014
3.	Measurement of short circuit impedance and load loss	The tolerance for percentage impedance is $\pm 7.5\%$ of the nominal value in section 4.5 of this specification.	Clause 11.4 of AS/NZS 60076.1:2014
4.	Measurement of no load loss and current	Section 4.7 of this specification.	Clause 11.5 of AS/NZS 60076.1:2014
5.	Induced over voltage withstand test	No collapse in test voltage	Clause 12 of AS/NZS 60076.3:2008
6.	Separate source voltage withstand test	Section 4.5 of this specification.	Clause 11 of AS/NZS 60076.3:2008
7.	Insulation resistance	$\geq 1\text{G}\Omega$	Clause 11.12 of AS/NZS 60076.1:2014
8.	Tightness test	No leaks.	Clause 11.8 of AS/NZS 60076.1:2014

4.9.4 Submission of test result

The following information in printed or electronic (printable) format shall be submitted for all the tests that need be performed.

1. The test method used. This may be a reference to an AS/NZ, IEC, IEEE or BS standard or to authenticated document or book or a method acceptable to Endeavour Energy.
2. Clearly stated and descriptive document with necessary diagrams, sketches, circuit diagrams and photographs etc. describing the test method.
3. Test results
4. Acceptable criteria

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Duplicate copies of routine test certificates shall be supplied with each transformer in the format shown in Annexure 1. An electronic copy of the routine test certificate in .csv format shall also be sent by e-mail to Endeavour Energy on a monthly basis to facilitate automatic uploading of results to Endeavour Energy's database

4.10 Maintenance requirements

4.10.1 Spare parts and maintenance

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 transformer installation. The list, together with prices, shall be indicated in the appropriate schedule. The supplier must also provide details (if required) of the recommended maintenance and the frequency at which it must be carried out. Details of the manufacturers repair capability and options shall be provided.

4.10.2 Failure mode analysis and preventative maintenance

The supplier shall indicate and provide updates to Endeavour Energy the mean time between failures (MTBF) of the transformer and its components including the recommended maintenance regime and maintenance tasks and intervals. This regime shall be based on the 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 in the offer.

4.11 Quality assurance

Quality assurance certification is required to establish the manufacturers ability to design and consistently manufacture transformers to this specification. The supplier and all its contractors shall have a quality system which 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 is 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.

4.11.1 Quality assurance plan

A quality assurance plan is 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; and
- A plan detailing the design, ordering of materials, manufacturing and test plans.

4.11.2 Quality Inspection and Test Plan (QITP)

A quality inspection and test plan shall be developed and agreed which contains sufficient details of the workflow so that Endeavour Energy can review and / or make visits. The test plan shall be prepared in accordance with AS/NZS ISO 9001.

4.12 Product approval

4.12.1 Product approval and audit forms

In addition to all transformer technical data, complete information on items such as the core, insulating paper and conductor materials used shall be provided on Branch Form FAE 3009.

4.12.2 Product approval process

Endeavour Energy will approve the equipment/components for use on the network. The transformer shall be evaluated under the product approval process set out in PAE 1004.

5.0 Authorities and Responsibilities

General Manager Asset Management shall have the authority and responsibility for:

- approving this Specification, including any variations;
- making all decisions concerning compliance in respect to this Specification;
- nominating Endeavour Energy's representative(s) for either the manufacturing facility inspection and/or witness testing; and,
- delegating any of these authorities and responsibilities to the Manager Asset Standards & Design.

Manager Asset Standards & Design shall have the authority and responsibility for:

- reviewing this specification and making recommendations to the General Manager Asset Management; and,
- making recommendations concerning compliance in respect of this Specification; and
- making nominations of Endeavour Energy's representatives.

Substation Assets Manager shall have authority and responsibility for:

- reviewing all type and routine test reports and alternative proposals submitted for evaluation and making recommendations to the Manager Asset Standards & Design.
- clarifying all the technical aspects of this specification to the stakeholders; and
- approving the relevant actions required and outlined in this specification.

Transformer Workshop Manager shall be responsible for:

- receiving and accepting transformers that conform to Endeavour Energy specifications.
- determining all routine tests comply with Endeavour Energy's requirement.
- implementing only approved transformers are used in Endeavour Energy's distribution network.
- comparing NLL and LL with the guaranteed values.
- notifying manufacturers/suppliers and relevant sections regarding non-conformance.
- determining that all test results received are uploaded to Endeavour Energy's database within seven (7) days of receipt of the information

Construction Coordination Manager, Network Connections shall be responsible for ensuring that all transformers installed by Level 1 Accredited Service Providers comply with the requirements of this Specification.

Commercial Manager has the authority and responsibility to certify that the transformers purchased through the tender process complies with the requirements of this specification.

Manufacturers/suppliers shall be responsible for:

- establishing awareness of their responsibilities under this specification;
- determining the contractor/s under their control have provided suitable training for their staff;
- 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.

Annexure 1 – Transformer routine test report

TRANSFORMER ROUTINE TEST REPORT

Manufacturer: _____ Date of Test: _____

Transformer Serial No: _____

TRANSFORMER RATING DETAILS

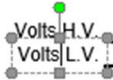
Capacity: _____

Phases: _____

Frequency: _____

Tapping: _____

Vector Group Connection: _____



Amps H.V. _____

Amps L.V. _____



VOLTAGE RATIO TEST

Taps	A-Phase	B-Phase	C-Phase
1			
2			
3			
4			
5			
6			
7			

INDUCED OVERVOLTAGE TEST

Duration: _____	Pass/Fail _____
Voltage: _____	
Frequency: _____	

APPLIED VOLTAGE TEST

Duration: _____	Pass/Fail _____
HV to LV & E: _____	
LV to HV & E: _____	

ETS 0066 Pole substation distribution transformers

INSULATION RESISTANCE TEST

at	kV D.C.	Pass/Fail
	M Ohms	
HV to LV & E:		
LV to HV & E:		

RESISTANCE TEST

at	°C		
HV Terminals	Ohms	LV Terminals	Ohms
A-B		a-b	
A-C		a-c	
B-C		b-c	

NO LOAD LOSSES

Frequency	Voltage	Current a	Current b	Current c	Mean Current	Current %	No Load Loss

FULL LOAD LOSSES

at	°C				
Test Voltage	Current A	Current B	Current C	Current Mean	Measured Loss

at 75°C	
Full Load Loss	Impedance

TRANSFORMER TESTED POWER EFFICIENCY: _____

MEPS REQUIREMENT: _____ Loss Criteria Complied with Yes / No

ADDITIONAL NOTES: _____

Produced by Asset Standards and Design Branch

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