Discipline
Engineering Standard – NSW

Category
Electrical

Title
Substation Auxiliary Transformer from Rectifier Transformer Secondary

Reference Number
PDS 01 – (RIC Standard: EP 05 00 00 01 SP)

Document Control

Status	Date	Prepared	Reviewed	Endorsed	Approved
Issue 1 Revision 2	Mar 05	Standards and Systems	Signalling Standards Engineer	GM Infrastructure Strategy & Performance	Safety Committee
		Refer to Reference Number	T Moore	M Owens	Refer to minutes of meeting 24/01/05

Disclaimer

Australian Rail Track Corporation has used its best endeavors to ensure that the content, layout and text of this document is accurate, complete and suitable for its stated purpose. It makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems of work or operation. Australian Rail Track Corporation will not be liable to pay compensation in respect of the content or subsequent use of this document for any other purpose than its stated purpose or for any purpose other than that for which it was prepared except where it can be shown to have acted in bad faith or there has been willful default.

Document Approval

The technical content of this document has been approved by the relevant ARTC engineering authority and has also been endorsed by the ARTC Safety Committee.

Document Supply and Control

The Primary Version of this document is the electronic version that is available and accessible on the Australian Rail Track Corporation Internet and Intranet website.

It is the document user's sole responsibility to ensure that copies are checked for currency against the Primary Version prior to its use.

Copyright

About This Standard

This document details the whole of life performance requirements for the purchase and maintenance of a substation indoor auxiliary transformer that is supplied from one of the 600 V secondary windings of a rectifier transformer. The substation auxiliary transformer provides the supply for the auxiliary services in Australian Rail Track Corporation (ARTC) traction substations.

This document does not cover auxiliary transformers supplied from a rectifier transformer with 2420 V secondary windings or auxiliary transformers that are supplied from a high voltage busbar. Auxiliary transformers with a three-phase 220 V secondary winding are also not covered.

Document History

Primary Source – RIC Standard EP 05 00 00 01 SP Version 1.0

List of Amendments –

ISSUE	DATE	CLAUSE	DESCRIPTION
1.1	05/01/2005		Reformatted to ARTC Standard
1.2	11/03/2005	Disclaimer	Minor editorial change

Contents

1 Scope and Application

This document details the whole of life performance requirements for the purchase and maintenance of a substation indoor auxiliary transformer that is supplied from one of the 600 V secondary windings of a rectifier transformer. The substation auxiliary transformer provides the supply for the auxiliary services in Australian Rail Track Corporation (ARTC) traction substations.

This document does not cover auxiliary transformers supplied from a rectifier transformer with 2420 V secondary windings or auxiliary transformers that are supplied from a high voltage busbar. Auxiliary transformers with a three-phase 220 V secondary winding are also not covered.

The requirements of this document apply from this document's date-of-issue to all new auxiliary transformers that are supplied from one of the 600 V secondary windings of a rectifier transformer.

2 References

2.1 Australian Standards

The following Australian Standards are either referenced in this document or can provide further information.

AS 1939	1990	Degrees of protection provided by enclosures for electrical equipment (IP Code)
AS 2374.1	1997	Power transformers Part 1: General
AS 2374.2	1982	Power transformers Part 2: Temperature rise
AS 2374.3	1982	Power transformers Part 3.0: Insulation levels and dielectric tests – General requirements
AS 2374.3.1	1992	Power transformers Part 3.1: Insulation levels and dielectric tests – External clearances in air
AS 2374.5	1982	Power transformers Part 5: Ability to withstand short-circuit
AS 2374.6	1994	Power transformers Part 6: Determination of transformer and reactor sound levels
AS 2700	1985	Colour standards for general purposes
AS 2735	1984	Dry-type power transformers
AS/NZS 61000.3.6	2001	Electromagnetic Compatibility (EMC) Part 3.6: Limits – Assessment of emission limits for distorting loads in MV and HV power systems (IEC 61000-3-6:1996, MOD)

2.2 ARTC documents

PDS 16 "Transformer Loss Evaluation".

PDS 04 “System Substation Earthing”.

2.3 Drawings

The following drawings form part of this document:

None.

3 Definitions and abbreviations

For the purpose of this document the definitions given in AS 2374 apply. In addition the following definitions also apply:

Primary winding

The winding that receives the active power from the supply system, usually the winding having the highest rated voltage.

Principal tapping

Is the mean tapping position. It is also the tapping to which the rated quantities are related.

Secondary winding

The winding that delivers the active power to the load circuit, usually the winding having the lowest rated voltage.

4 Introduction

The 1500 V traction system is unearthed, therefore the secondary of the rectifier transformer and the primary of the auxiliary transformer cannot be earthed. Special design considerations are required to ensure that the transformer will not be affected by faults on the traction system.

5 Functional characteristics

5.1 General

The substation auxiliary transformer provides the supply for the auxiliary services in ARTC traction substations. The transformer primary winding is supplied from one of the secondary windings of a rectifier transformer. The rectifier transformer supplies a series bridge rectifier for the 1500 V traction system.

The auxiliary services include lighting, low voltage power, dc power supplies, ventilation and compressed air. They are not used for supplying dc traction loads. The auxiliary services may be three-phase 415 V or single phase 240 V.
The traction substations are in the area bounded by Newcastle (north), Dapto (south) and Lithgow (west).

5.2 Whole-of-life cost

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

- Initial purchase price.
- Cost of changes to the Technical Maintenance Plan and Service Schedules or the creation of new manuals and schedules.
- Cost of manuals.
- Cost of maintenance.
- Cost of replacement parts.
- Cost of inventory spares.
- Environmental costs.
- Electrical losses. Refer to document PDS 16 “Transformer Loss Evaluation” for the method of evaluating transformer losses.
- Cost of installation.
- Reliability and cost of failures.
- Cost of modifications to other parts of the installation.
- Lifetime of equipment.
- Discount rate.
- Cost of staff training.
- Cost of decommissioning and disposal.
- Cost of special tools.
- Cost of changes and management of drawings.

6 Performance characteristics

Number of phases	1 or 3.
Frequency	50 Hz.
Type	Indoor, Enclosed dry-type.
Type of cooling	Air natural.
Rated Voltages	Primary 600 Vrms
	Secondary 240 $_{Vrms}$ (1ϕ) or 415 $_{Vrms}$ (3ϕ)
Tappings	Full kVA tappings on the primary winding at ± 2.5% and ± 5% of the principal tapping. The tappings shall be controlled by off-circuit bolted links.

System highest voltage	Primary	3.6 kVrms
	Secondary	1.1 kVrms
System earthing	Non-effectively earthed.	
Rated insulation level	Primary	16 $_{kVrms}$ (power frequency)
Connection vector symbol	Dyn 1 (three-phase transformer).	
Neutral terminal	Star point of lower voltage winding shall be connected to a suitable terminal and fully insulated from earth.	
Impedance voltage at rated current and 75°C	Refer to AS 2374.5, Table 1.	
Sound pressure level	Refer to AS 2374.6, Appendix AA.	
Special physical characteristics	Refer to section 7.	

7 Technical characteristics

7.1 Rated insulation level

The primary winding(s) are connected to the unearthed secondary of the rectifier transformer. During fault conditions, the voltage to earth of this winding can exceed 3.5 $_{kVdc.}$ Special attention is drawn to the rated insulation level requirements in section 6.

7.2 Harmonic voltages

The rectifiers create high harmonic distortion of the current waveform. This distorted current waveform interacts with the impedance of the rectifier transformer resulting in harmonic voltages. The design of the auxiliary transformer must therefore take these harmonic currents and voltages into account.

7.3 Rating plate

The rating plate shall meet the requirements of AS 2374.1, Clause 7, and shall include a diagram of connections. A terminal marking plate complying with the requirements of AS 2374.1, Clause ZC7, shall also be attached to the transformer. The plates shall not be attached to a removable cover.

7.4 Terminal arrangement

The three primary winding leads and the four secondary winding leads (two leads per winding for 240 V) shall be brought out from each transformer winding and terminated on screwed terminal studs suitable for use with crimp lugs. The terminals shall be suitably proportioned and marked to the requirements of AS 2374.1, Clause ZC4. An insulated barrier shall separate the primary terminals and the secondary terminals. The complete arrangement shall be enclosed in the transformer enclosure.

7.5 Enclosure

The transformer shall be enclosed to meet the requirements of AS 2735 Clause 1.5.2.3 and AS 1939 with a degree of protection of IP21.

A method for securing the input and output cables shall be incorporated into the enclosure.

7.6 Earth terminal

An earthing terminal suitable for the connection of a 70 mm^2 cable shall be located externally on the transformer enclosure.

7.7 Lifting attachments

Suitable lifting lugs shall be provided for lifting the transformer.

7.8 Temperature-rise limits

The transformer shall be capable of continuous operation at rated power without exceeding the maximum temperature-rise limits as specified in AS 2374.2, Clause 4.2.

7.9 Finish

The transformer enclosure (internal and external) shall be painted with a smooth semi-gloss enamel.

8 Maintenance

The relevant ARTC Technical Maintenance Plans (TMP) shall be adhered to for the maintenance of the type of transformer. Where a new type of transformer is purchased and installed that is not covered by the TMP, then a new service schedule shall be created and the TMP updated. This shall include:

- The “Maintenance Policy”, defining the practical means of maintaining the equipment.
- The tasks to be performed at each level of maintenance and staff skill levels required.
- Test equipment and tools.

It is preferable that the period for routine maintenance shall not be more frequent than for the types of transformers currently detailed in the ARTC Technical Maintenance Plan.

9 Tests

9.1 Acceptance tests

Routine tests shall be carried out on each transformer to AS 2374.1 Clause 10.1.1. The results shall be recorded. A record of a test certificate for type tests carried out on a similar transformer to AS 2374.1 Clause 10.1.2 shall also be available for each transformer.

9.2 Periodic tests

Refer to ARTC Technical Maintenance Plan.

10 Data set associated with the equipment

The following data shall be maintained for each transformer. This data shall be the property of ARTC and maintained by the Maintenance Provider responsible for the installation in which the transformer is installed.

10.1 Equipment manuals

The Equipment Manuals must be provided for the installation and shall include full instructions for the preventative, surveillance and corrective maintenance, comprehensive fault diagnosis, rectification procedures and staff training requirements. It shall include all drawings needed for the above. All drawings shall show sufficient detail to enable satisfactory maintenance of the equipment.

10.2 Test results

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

10.3 Life cycle costing

All the data and assumptions pertaining to the determination of the whole-of-life cost calculations shall be recorded.

10.4 Technical information

The information listed in the attached Technical Schedule shall be maintained for each transformer.

11 Technical schedule

Manufacturer ..... _____

Serial number ..... _____

Year of manufacture ..... _____

Rated primary voltage ..... _____ V

Rated secondary voltage ..... _____ V

Rated power ..... _____ kVA

Connection vector symbol ..... _____

Maximum temperature rise of windings ..... _____ °C

Impedance voltage at rated current and 75°C/115°C*
(Expressed as percentage of rated voltage) ..... _____ %

No-load current with rated voltage applied to the principal
tapping (Expressed as percentage of rated current) ..... _____ %

No-load current with 110% of rated voltage applied to the principal
tapping (Expressed as percentage of rated current) ..... _____ %

No-load loss ..... _____ W

Load loss ..... _____ W

Type of core steel - hot or cold rolled ..... _____

Brand or trade name and grade of core steel ..... _____

Flux density based on net cross-section of steel with rated
voltage at rated frequency applied to the principal tapping

Limbs ..... _____ T

Yoke ..... _____ T

Mass of windings only ..... _____ kg

Mass of transformer core and windings only ..... _____ kg

Mass of one transformer complete with metal enclosure ..... _____ kg

Mean audible sound level ..... _____ db

Voltage withstand test:

primary terminals - Lightning impulse withstand voltage ..... _____ kV_p

- Power frequency withstand voltage ..... _____ kV_{rms}

secondary terminals - Power frequency withstand voltage ..... _____ kV_{rms}

Terminals, minimum clearance in air:	primary	secondary
between phases	_____ mm	_____ mm
phase to earth	_____ mm	_____ mm

Is heat-shrink material provided on the primary terminals? ..... * YES / NO

Type of insulating material used for windings ..... _____

Type of material used for windings - copper or aluminium ..... _____

Temperature class of insulation ..... _____

Overall transformer dimensions:

Length ..... _____ mm

Width ..... _____ mm

Height ..... _____ mm

Protective treatment applied to:

Internal surfaces ..... _____

External surfaces ..... _____

* Cross out where not applicable.

Departures from Specification

Are there any departures from the requirements of this

Specification ..... * YES / NO

Departures from the requirements of this Specification must be highlighted.