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**Discipline**

**Engineering Standard - NSW**

**Category**

**Electrical**

**Title**

**Electrical Power Equipment - Integrated Support Requirements**

**Reference Number**

**POP 01 - (RIC Standard: EP 00 00 00 12 SP)**

**Document Control**

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		Refer to Reference Number	T Moore	M Owens	Refer to minutes of meeting 24/01/05

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## **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.

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## About This Standard

This document details the integrated support requirements common to most major electrical equipment in the ARTC high voltage and traction networks. It is designed to be used in conjunction with ARTC technical standards for individual electrical equipment and contains information to facilitate the support of the ARTC asset management systems including maintenance management, configuration management, quality management, risk management and financial processes.

To achieve best practice ARTC is continually developing its asset support requirements related to its business objectives. This document will aid in the provision of information required to determine the full life cycle cost of electrical equipment through their acquisition, operational and disposal phases.

The release of this document may affect the operation or maintenance of existing electrical equipment in the ARTC high voltage or traction network. Where integrated support requirement work is undertaken on existing equipment it shall comply with this document.

## Document History

**Primary Source** – RIC Standard EP 00 00 00 12 SP Version 1.1

### 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

About This Standard .....	3
Document History.....	4
<b>1 Scope and Application .....</b>	<b>7</b>
<b>2 References .....</b>	<b>7</b>
2.1 ARTC Engineering Standards .....	7
2.2 Australian Standards .....	7
2.3 ARTC templates .....	8
2.4 Definitions .....	8
<b>3 Integrated Support Requirements .....</b>	<b>8</b>
3.1 Integrated Support Objectives .....	8
3.2 Maintenance Requirements .....	9
3.2.1 Scheduled Maintenance .....	9
3.2.2 Maintenance Requirements Analysis (MRA) .....	9
3.2.3 Failure Modes, Effects and Criticality Analysis (FMECA) .....	10
3.2.3.1 FMECA Worksheet documentation .....	10
3.2.4 Technical Maintenance Plan (TMP) .....	12
3.2.4.1 Service Schedule standard terminology .....	13
3.3 Spares Support .....	14
3.3.1 Spares Assessment Methodology .....	14
3.3.2 Recommended Spares List .....	15
3.3.3 Packaging, Storage and Handling .....	15
3.4 Operation and Maintenance Manual .....	15
3.4.1 General .....	15
3.4.1.1 Word Processor Configuration for Custom Produced Manuals .....	17
3.4.1.1.1 Text Styles and page settings .....	17
3.4.1.1.2 Table of Contents .....	18
3.4.1.1.3 Page Numbering .....	18
3.4.1.1.4 Numbering methodology .....	18
3.4.1.1.5 Page Header .....	19
3.4.1.1.6 Page Footer .....	19
3.4.1.1.7 Warnings and Cautions .....	19
3.4.2 Submission of Documentation .....	19
3.4.2.1 Document Numbering .....	20
3.4.2.2 Inclusion of Drawings and Photographs .....	20
3.4.2.3 Folders .....	20
3.4.2.3.1 Covers and Spines .....	20
3.4.2.3.2 Revision History .....	20
3.4.3 Scope of Manual .....	21
3.4.4 Validation of Content .....	25

3.5	Training .....	25
3.5.1	Training Requirements .....	25
3.5.2	Operator Training .....	26
3.5.3	Maintenance Training .....	26
3.6	Facilities, Equipment and Special Tools .....	27
<b>Appendix A Technical Schedule .....</b>		<b>28</b>
<b>Appendix B Request for Tender (RFT) Checklist .....</b>		<b>30</b>

## 1 Scope and Application

This document details the integrated support requirements common to most major electrical equipment in the ARTC high voltage and traction networks. It is designed to be used in conjunction with ARTC technical standards for individual electrical equipment and contains information to facilitate the support of the ARTC asset management systems including maintenance management, configuration management, quality management, risk management and financial processes.

To achieve best practice ARTC is continually developing its asset support requirements related to its business objectives. This document will aid in the provision of information required to determine the full life cycle cost of electrical equipment through its acquisition, operational and disposal phases.

The requirements of this document apply when a new piece of major electrical equipment is installed in the ARTC high voltage or traction networks in conjunction with the relevant ARTC standard for the equipment.

The release of this document may affect the operation or maintenance of existing electrical equipment in the ARTC high voltage or traction network. Where integrated support requirement work is undertaken on existing equipment it shall comply with this document.

## 2 References

The following documents are either referenced in this standard or can provide further information.

### 2.1 ARTC Engineering Standards

AM 9995 PM	ARTC Maintenance Requirements Analysis Manual
PMP 01	Electrical Technical Maintenance Coding System

### 2.2 Australian Standards

AS 1000	The International System (SI) units and their application
AS 1100	Parts 101 & 201 Technical Drawing
AS 1102	Graphical symbols for electrotechnical documentation
AS 1470	Health and Safety at work – Principles and Practices
AS 9001	Quality Systems – Model for Quality assurance in design/development, production, installation & servicing

## 2.3 ARTC templates

The following templates are to be provided for documentation of maintenance analysis, maintenance plan and maintenance service schedules.

Use	Filename
FMECA	Blank FMECA sheet.xls
Service schedule(s)	Blank service schedule sheet.xls
TMP	Blank TMP sheet.xls

A major item of equipment/item/component that may be removed from its operating position for scheduled maintenance and subsequently reinstalled or replaced with a serviceable equivalent.

A non repairable component which is damaged or wears due to use and is replaced with new component when necessary or where predetermined wear limits are reached, (items such as contacts, lubricants, etc).

Repairable item	An equipment component which may be removed from its operating position for maintenance, restored to a predetermined serviceable condition and reinstalled for a further use, such as switchgear bushings, high speed circuit breaker.
Insurance spare	<p>An equipment component purchased and stored as replacement component for use in repairing the systems to serviceable condition subsequent to the occurrence of a major incident that causes secondary damage, such as damage to OHW, train derailment and the like.</p> <p>Insurance spares are normally components that are susceptible to sustaining damage beyond economical repair if involved in an incident and/or, have excessive lead times for replacement, and are required to restore a system to service.</p>
Maintenance requirements analysis (MRA)	The process of determining the range of tasks in the maintenance schedules that will preserve the inherent levels of reliability of the design and which provide an effective and efficient means of keeping the equipment in the condition required.

## 3 Integrated Support Requirements

### 3.1 Integrated Support Objectives

The information required to operate and maintain the equipment throughout the operational life, in a cost effective manner and to a level that is consistent with the planned operational performance and usage of the systems shall be developed and provided.

This includes:

- Maintenance Requirements
- Spares Support
- Operations and Maintenance Manuals
- Training, and
- Support Equipment and Tooling

### **3.2 Maintenance Requirements**

#### **3.2.1 Scheduled Maintenance**

The planned maintenance requirements for the equipment shall be developed and provided. Planned maintenance requirements shall as a minimum include the following, to the extent applicable to the design:

- Pre-operating procedures.
- Preventive maintenance, including service/lubrication tasks, condition monitoring requirements, scheduled restore/discard tasks, failure finding testing and any other tasks considered appropriate for all installed systems and equipment.
- Recommended overhaul requirements, including the recommended overhaul interval and location (onsite/depot/service centre).
- Details of any items subject to finite replacement or inspection lives, including structural inspections where applicable.

Maintenance checklists and procedures necessary to carry out the proposed tasks shall be defined.

Maintenance checklists and procedures shall include information on consumable items used as part of the task and reference to any special tools, facilities or equipment needed to perform the task as well as any special skills and/or training necessary for the task.

The recommended maintenance requirements established as a result of this activity shall be documented in the form of a Technical Maintenance Plan – as defined in 3.2.4.

#### **3.2.2 Maintenance Requirements Analysis (MRA)**

The MRA process shall be undertaken in accordance with the ARTC Maintenance Requirements Analysis Manual AM 9995 PM, which is based upon a Failure Modes, Effects and Criticality Analysis (FMECA) and Reliability Centred Maintenance (RCM) methodology. (see below)

The results of the MRA shall be documented and supplied. The Hazards and Occupational Health and Safety (OH&S) implications resulting from the MRA shall

also be analysed and documented prior to completion of the respective sets of Service Schedules.

The analysis and documentation shall be undertaken using either the OEM's in-house software tools, or the templates provided. Where in-house tools are used, hard and electronic copy of the analysis shall be provided in an agreed format to allow transfer of the information into the maintainer's systems.

### **3.2.3 Failure Modes, Effects and Criticality Analysis (FMECA)**

A Failure Modes, Effects and Criticality Analysis (FMECA) shall be completed, documented and supplied as part of the MRA. The FMECA serves to identify potential failure modes that must be considered as part of the reliability estimation process for a specific item and to provide information on those that should receive highest priority for reliability improvement. The FMECA also provides the basis for development of programmed maintenance requirements and for identifying failure modes and effects for consideration as part of the Safety program.

The FMECA will be conducted down to the Lowest Replaceable Unit level. The FMECA process shall be completed and documented to either:

- ARTC's requirements as specified in the Maintenance Requirements Analysis Manual AM9995PM, or
- the OEM's standard, provided that the approach meets the basic objectives set out within the potential Failure Mode and Effect Analysis Handbook, which forms part of the set of documentation for the QS 9000 supplement to QS 9000 Quality Systems. The FMECA shall be documented using the OEM's FMECA software tool.

The purpose of the FMECA is to review and analyse the equipment's design to establish:

- Potential or demonstrated failure modes for each significant item within the design. This will be carried out at the replaceable subassembly level.
- The likelihood of failure for each identified failure mode, where possible expressed in terms of failure per million operating hours.
- The effect of failure in terms of the impact on safety, operating performance, environmental impact and economic consequences, including damage to other equipment.
- The criticality of failure in terms of operation of the system, that is, whether trains can continue to operate without delay or whether the rail systems/subsystem can continue to operate after the failure has occurred.

#### **3.2.3.1 FMECA Worksheet documentation**

The following table provides definition of the information to be included in the FMECA.

Heading	Requirement
<b>Item/Assembly, Part No and Drawing No.</b>	Identify the asset, manufacturer's part identification, and drawing details
<b>Analyst</b>	Identify the analyst(s) who prepared the FMECA
<b>Functional description.</b>	Provide an overview description of the asset's function
<b>MTBF (hrs)</b>	Enter the asset/item's <b>Mean Time Between Failure</b> in hours
<b>Function</b>	<p>Principal functions - which represent the business reason for an assets existence. Enter the item name and as concisely as possible the function(s) of the item to meet the design intent. Functions may also be identified in the form of a desired standard of performance with functional failure deemed to have occurred when this level of performance is not available. Include information regarding the environment in which the system operates. (eg, define temperature, voltage etc).</p> <p>Ancillary function - which provide additional useful functions either as enhanced capability, additional capability or opportunistic.</p> <p>Protective function - such as alarms and automatic shutdowns</p>
<b>Part</b>	The component part within the Item/Assembly which fails
<b>Failure mode</b>	Failure modes are the effects by which failures are observed. It includes the manner by which the failure is observed & is generally described by the way in which the failure occurs and its impact, if any, on the equipment operation. Ie broken, seized, excessive vibration.
<b>Cause of Failure</b>	Need to state the engineering mechanism of failure that leads to the particular functional or conditional failure. Failure causes are derived from the design. They are associated with the detailed design approach taken, the materials used, the operating environment including such information as physical loads and corrosive materials. Human factor information is also required, to support the allocation of warning notices in manuals or service schedules.
<b>Local effects</b>	<p>Identify that impact a particular failure mode has on the operation, function or status of an item. The description of the failure effect must be adequately detailed to allow classification into one of the four categories of consequences:</p> <p style="padding-left: 40px;">Hidden/safety/environment</p> <p style="padding-left: 40px;">Evident/safety/environment</p> <p style="padding-left: 40px;">Evident/economic</p> <p style="padding-left: 40px;">Hidden/economic</p>

Heading	Requirement
<b>Failure Rate</b>	Identify the rate (in failures per million hours) at which this failure mode/cause combination occurs. If data is not available to establish exact rates, enter the indicative percentage (with % symbol) that this failure mode / cause combination represents out of the total failures
<b>Tasks</b>	<p>Identify maintenance task which addresses the failure mode/cause. Needs to be split maintenance tasks into and “on” or “off” system. The maintenance task must fall into one of the following categories:</p> <p style="padding-left: 40px;">Service / lubrication task</p> <p style="padding-left: 40px;">Condition monitoring task include examinations for indications of conditional failure before they lead to functional failure</p> <p style="padding-left: 40px;">Scheduled restoration or rework at some hard time conducts a schedule of maintenance tasks</p> <p style="padding-left: 40px;">Scheduled discard which at some time removes an item from the system</p> <p style="padding-left: 40px;">Failure finding task which is only applicable to hidden functional failures where a confidence check that the system is still operational is required at some interval to reduce the probability of multiple failures</p>
<b>Type</b>	Identify type of Maintenance Task using the code letters on the worksheet.
<b>Period</b>	Frequency for the maintenance Task - time, operational count, operational event(s), etc

**Table 1 – FMECA worksheet**

### 3.2.4 Technical Maintenance Plan (TMP)

The recommendations resulting from the maintenance analysis process shall be documented in the form of a Technical Maintenance Plan (TMP) for the system using the ARTC Service Schedule and TMP Templates.

The TMP shall include details of:

- The equipment.
- All scheduled maintenance activities for the equipment.
- The intervals (periodicity) at which each maintenance schedule should be performed.

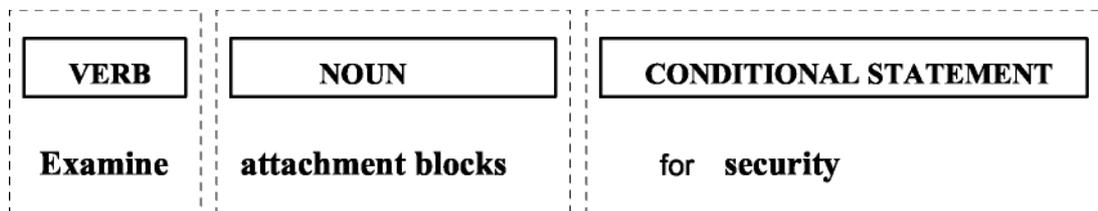
- Skills and competencies for completion of each major task in the schedule. Note that for the purposes of the TMP a “task” may comprise a number of actions performed as part of a scheduled examination.
- Recommended location at which the schedule is to be completed eg on-site, depot, workshop, central facility, etc.
- Details of special facilities or equipment necessary for completion of the schedule.
- Reference to technical data or inspection schedules required for completion of the task.
- Checklists for recording the results of the maintenance processes.

The terminology used in the service schedule tasks shall be in accordance with 3.2.4.1. Refer to section 4.3.6 of AM 99 95 PM ARTC Maintenance Requirements Analysis Manual for further details.

### 3.2.4.1 Service Schedule standard terminology

The words used to define maintenance actions shall be standardised to ensure consistency of approach and to assist the transfer of information across application boundaries. Consistency of task description enables the provision of a common interpretation of instructions and task directives by all support staff.

Each task statement should have the standard structure shown at Figure 1



**Figure 1 - Standard task statement structure**

The verbs are the key words which define the task action and have a standardised description. The remainder of the statement will depend on the particular item and failure mode and hence use conventional English meanings. These key verbs are listed in Figure 2:

Verb	Detailed requirement
Examine	Carry out a visual survey of the condition of an item without dismantling (unless directed to do so by the maintenance instruction).
Lubricate	Apply a specified lubricant (e.g. oil type XYZ, grease type ABC) to a specified area of equipment (often specified in a separate lubrication chart).

Check	Make a comparison of a measurement of some quantity (e.g. time, pressure, temperature, resistance, dimension) to a known value (accept/reject criteria) for that measurement and if required rectify and/or replenish if necessary.
Check Operation or Operate	Ensure that an item of equipment or system functions correctly as far as possible without the use of test equipment or reference to a measurement.
Clean	Remove contaminating materials (e.g. dust, dirt, moisture, excessive lubricant) from an item of equipment.
Adjust	To alter as necessary to make an item compatible with system requirements.
Test	Determine by using appropriate test equipment that a component of equipment functions correctly.
Replenish	Refill a container to a predetermined level, pressure or quantity and undertake associated access and closure tasks.
Fit	Correctly attach an item to another.
Refit	Fit an item that has been previously been removed.
Calibrate	Make a comparison of a measurement of time, pressure, temperature, resistance, dimension or other quantity to a known standard (usually a NATA laboratory function).
Disconnect	Uncouple or detach cables, pipelines or controls.
Reconnect	Reverse of disconnect.
Safetyseal	Securing of equipment which requires the breaking of a seal to manually operate (usually associated with emergency equipment).
Remove	Correctly detach one item from another.
Secure	To make firm or fast.

**Figure 2 - Task verbs - standard terminology**

### 3.3 Spares Support

#### 3.3.1 Spares Assessment Methodology

The need for spare parts shall be assessed and the spare parts list developed using a clearly defined methodology.

The methodology shall use established failure rates and the related maintenance policies, and identify the range and quantity of spares to be made available at any time to maintain the systems and ensure they meet the availability requirements. The need for insurance spares to meet unplanned needs shall be addressed, and a separate assessment process used to identify, quantify and list these insurance spares.

The methodology to be used for the assessment of spares requirements must be included in the Maintenance Plan.

### 3.3.2 Recommended Spares List

A recommended spares list shall be developed and provided. The recommended spares list must define the recommended range and quantity of rotatable and repairable items, consumables and insurance spares to support the planned operational usage with the recommended maintenance policies.

The recommended spares list shall be developed and refined during the design and construction of the equipment.

The recommended spares list shall include the following information:

- item identification (name, manufacturers part or reference number and specification, as appropriate);
- recommended spares quantities;
- expected price;
- source;
- procurement lead time;
- failure rate;
- number of items installed in the equipment
- predicted usage rate and whether the item is consumable or is used in support of scheduled preventative maintenance; and
- probability of the required item being available based on the recommended spares quantity and procurement lead time.

### 3.3.3 Packaging, Storage and Handling

The requirements for packaging, storage and handling shall be provided for all recommended spares.

## 3.4 Operation and Maintenance Manual

### 3.4.1 General

An Operations and Maintenance Manual shall be provided for the equipment, and shall meet the requirements below. The manual shall be delivered in hard copy and in electronic format. (see below).

Manuals may be produced to meet the specification below, or supplied as standard manuals in the OEM's proprietary format, provided that the information required in 3.4.3 below is clearly contained within the combination of manuals, and any attachment. **Manuals shall only contain information about the equipment supplied.** Where the OEM's proprietary manuals contain information and references to multiple models of equipment, information relating to unsupplied equipment shall be clearly crossed or blanked out.

Hard copies of the manual shall have the following features:

#### Binding

- Bound; or
- Contained in white, durable, four ring hard cover binders, not greater than 50 mm thick, with the facility, equipment or plant identification permanently marked on the spine and outside cover with clear protection on the covers. Binders shall not be filled to more than 60% capacity.

#### Paper

- Not less than 80 gsm in weight, surface sized and suitable for offset/laser printing, in double-sided form;
- Text on A4 pages
- Illustrations on A3 size paper folded to A4 size

#### Typeface and layout

- Clear typeface;
- 35 mm margin for binding;
- Each section shall start on a right hand side page;

#### Organisation

- Divide sections with indexed plastic divider sheets ;
- Protect vulnerable and much used pages with plastic covers;
- Index the contents
- Locate illustrations and at the rear of the text. Small illustrations, to highlight matters, may be located in the text;
- Commence each document with a title sheet detailing as a minimum:
  - Name of System/Element/Item/Equipment;
  - Supply Contract Details (if applicable);
  - Name of Supplier (if applicable);
  - Address for Service Calls (if applicable), and
  - Document version # and date of issue

The electronic form of the document shall be delivered in two forms:

- Microsoft Word97 format (for custom produced manuals),

- PDF File(s), with all headings down to level 3 linked to the appropriate page/section in the pdf file(s). The PDF files shall also include pdf versions of OEM information, Works/Test certificates and other hardcopy documents to produce a pdf version of the entire manual. Clear scanned images with a resolution for legibility incorporated into pdf files are acceptable. When the individual pdf files are generated they shall not be password protected, and shall be enabled for editing to enable the pdf file size to be reduced where required for more efficient intranet access.

Or

- Approved equivalent appropriate industry standard software as may be appropriate at the time of delivery of this documentation

### **3.4.1.1 Word Processor Configuration for Custom Produced Manuals**

#### **3.4.1.1.1 Text Styles and page settings**

The following settings and styles shall be used to produce the printed pages of the manual.

Page Size		A4
Margins	Top	2 cm
	Bottom	2 cm
Left		2 cm
Right		2 cm
Header (from edge)		1.25 cm
Footer (from edge)		1.25 cm
Gutter		1.5 cm

#### Text Styles

Heading 1	Arial, 14pt Bold, indent: hanging 2.06cm, paragraph spacing 12pt before, 6pt after, outline numbered, level 1
Heading 2	Arial, 12pt Bold, indent: left 1.25cm, hanging 1.73cm, paragraph spacing 6pt before, 6pt after, outline numbered, level 2
Heading 3	Arial, 12pt, indent: left 1.25cm, hanging 1.73cm, paragraph spacing 6pt before, 3pt after, outline numbered, level 3
Heading 4	Arial, 12pt, italic, indent: left 1.25cm, hanging 1.73cm, paragraph spacing 6pt before, 3pt after, outline numbered, level 4

Normal	Arial, 11pt, indent left 2.0cm, paragraph spacing 6pt before and after, line spacing (at least) 12 point.
Table text	Arial, 11pt, left indent 0.1cm, right indent 0.1cm paragraph spacing 1pt before and after, line spacing (at least) 12 point.
Caption	Arial, 8pt, bold, centred, paragraph spacing 3pt before and after.
Warning	Normal + indent left 3.0cm, indent right 2.5cm
Header	Arial, 10pt italic, Tabs:9cm centred, 15.5cm right flush
Footer	Arial, 10pt italic, Tabs:9cm centred, 15.5cm right flush

#### **3.4.1.1.2 Table of Contents**

The table of contents for the manual shall commence on page iii of the document and the table shall be created from style heading levels 1 to 4 inclusive. It shall be followed by a list of Figures and a list of Tables.

#### **3.4.1.1.3 Page Numbering**

The introductory pages of the manual shall be numbered consecutively in roman numerals (i, ii, iii, iv etc).

Each section of the manual shall be consecutively numbered in Arabic numerals, and be presented as 'page x of y', where y is the number of pages in the section of the manual.

The introductory pages shall include the title page, Revision Control Table (see 6.1) and table of contents.

#### **3.4.1.1.4 Numbering methodology**

The sections and subsections of the manual shall be outline numbered. Sections shall be numbered sequentially from 1.0 and shall be style 'Heading 1'

Subsections shall be numbered sequentially within the section from n. 1 and shall be style 'Heading 2'

The section and subsection titles are listed in 6.1.

Tables may be used to where applicable to simplify the presentation of information and data interpretation. Tables shall be numbered sequentially within each section using Arabic numerals in the order they appear in the text. Table numbering shall be of the form 'Table n-1' where n is the section number and it shall prefix the title of the Table. The figure text shall be style 'caption'. The text within the tables shall be of style 'table text'.

Figures shall be numbered sequentially within each section using Arabic numerals in the order they appear in the text. Figure numbering shall be of the form 'Fig. n-1' where n is the section number and it shall prefix the title of the figure. The figure text shall be style 'caption'.

#### 3.4.1.1.5 Page header

The header shall be formatted as style 'header' and shall have a 1 pt border line below the header paragraph. The content of the header lines of each section shall be:-

Line 1

Manual Title	Left flush
Section Name	at Tab 9 cm, centred
Manual Number	at Tab 15.5 cm, right Flush

Line 2

Section Revision Date	Left flush
Section Revision Number	at Tab 15.5 cm, right Flush

#### 3.4.1.1.6 Page Footer

The footer shall be formatted as style 'footer' and shall have a 1 pt border line above the footer paragraph. The content of the footer lines of each section shall be:-

© Australian Rail Track Corporation	Left Flush
'Section n - page x of y'	at Tab 15.5 cm, right Flush

#### 3.4.1.1.7 Warnings and Cautions

Where it is essential for the protection of the staff and / or equipment the manuals shall include the appropriate Warnings, Cautions and notes. The format of the text shall be style 'Warning'. The content of a warning box shall not be split over two pages. Warnings and cautions shall not contain procedural steps, nor be numbered. Where the warning or caution contains more than one critical element, those elements should be separated by the use of bullet points for each separate element.

Warning shall be used for the protection of staff, Caution used for the protection of the equipment, and Note used to draw attention special requirements.

Where a combination of warning, caution or note appear together they shall appear in the order of Warning, Caution then Note as applicable.

### 3.4.2 Submission of Documentation

Operation and Maintenance Manuals shall be provided and be written in clear, concise English, produced in the format outlined above, and covering the following scope and content.

### 3.4.2.1 Document Numbering

The number format shall be AA aabbcc ZZ, where:

- AA is the relevant discipline code from the ARTC TMP,
- aabbcc represent the next three layers of the ARTC Technical Maintenance Code (TMC), and
- ZZ is “MP” for a manual covering a system or subsystem, or “EQ” where the manual covers only one equipment group.

Refer to PMP 01 “Electrical Technical Maintenance Coding System”.

Revision numbers for draft versions of the Manuals shall be A, B, C etc.

Revision numbers for approved versions of the Manuals shall be 1, 2, 3 etc.

The document number shall be unique and shall be registered in the ARTC master list of document numbers prior to document development commencing.

### 3.4.2.2 Inclusion of Drawings and Photographs

Figures and/or pictures should be included where appropriate to complement the manual text. They shall be used to:

- Present information difficult to describe by text alone;
- Provide identification of tools, parts etc;
- Halftone figures (photographs) where used, shall be suitable for electronic scanning and photocopying without loss of detail.

### 3.4.2.3 Folders

Where required the contents of the manual may be spread over multiple folders. Each folder shall be called a Volume. Where volumes are utilised, a complete table of contents for the entire manual shall be included in each volume, clearly indicating which sections are located in each volume.

#### 3.4.2.3.1 Covers and Spines

The cover page for each volume shall be inserted as the first page within each volume, and a copy inserted into the front cover of the volume.

The spine shall contain the Manual Identification Number, the volume number, and the numbers of the sections in the respective volume where the manual is split over more than one volume. The text shall be sized to suit the thickness of the folder. The spine identification box shall be positioned 5 cm from the top edge of the folder

#### 3.4.2.3.2 Revision History

The revision history of the manual shall be included in a Revision Control

Table on page ii of the Operations and Maintenance Manual. See following sample page for layout of revision control tables.

Sample Revision Control Table Page.

**Revision Control Table**

<b>Revision</b>	<b>Date of Approval</b>	<b>Summary of change</b>
1	Sept 2002	Original Issue
2	Dec 2002	Section 4.3 revised

**Current Subsection Revision**

<b>Subsection</b>	<b>Current Revision</b>	<b>Summary of change</b>
Title page	1	Original Issue
Revision Control	2	
Table of Contents	2	
1.0	1	Original Issue
2.0	2	Updated description of HV circuit breakers
3.0	1	Original Issue
4.0 – 4.2	1	Original Issue
4.3	2	Updated alarm test procedure
4.4-4.5	1	Original Issue
5.0	1	Original Issue
6.0	1	Original Issue
7.0	1	Original Issue
8.0	1	Original Issue

**3.4.3 Scope of Manual**

The following information shall be included (where applicable) in the general order detailed below, in separate Operation and Maintenance Manuals for separate operable systems, types of items, geographic areas and the like.

<b>Section 1</b>	<p><b>Purpose of the Manual</b></p> <p>1.1 Brief description of the Manual’s purpose, structure and content.</p> <p>1.2 References and associated publications and standards.</p> <p>1.3 Definitions.</p>
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## Section 2 Equipment Description

2.1 Physical Description of equipment and major components.

2.2 Principles and theory of operation. This section should explain enough so that fault finding can be sensibly carried out. Line type illustrations are appropriate. Summary of the key Design Parameters of the various elements of the equipment that need to be known in its operation, maintenance and management.

A basic working description, including features and any automatic control, operational purposes and functions of the components, systems and items.

For software oriented systems, functional specifications (hardware and software), systems programs, individual program modules, including flow charts and source codes, and the like.

2.3 Detailed component description. Each major component illustrated and described.

2.4 Operating Instructions and Procedures. Comprehensive details of technical information relevant to modes of operation with a step by step procedure arranged into sections, such as:

- Safety Procedures and inherent hazards to be documented including applicable material safety data sheets. This information will be used as input for Job Safety Analysis and pre work briefing. The JSA and pre work briefing to be undertaken by ARTC;
- Operating ratings and limitations due to temperature, pressure and flow, or other relevant factors;
- Checks before, and procedures for, Equipment Startup, Operations and Shutdown;
- Emergency Shutdown and Abnormal Operation;
- Full information on alarm and trip settings;
- Full details on condition monitoring capability including accept/reject criteria
- Links to inspection, servicing and maintenance schedules as defined in the Maintenance Plan;
- Any other information needed by operating staff to ensure the safe and efficient operation of the equipment.

<b>Section 3</b>	<b>Operational and functional checks</b>  Describe the tests required to confirm operation and whether the equipment and its components are functioning within acceptable limits. Specify accept and reject limits and tolerances.
<b>Section 4</b>	<b>On system maintenance</b>  <b>Refers to maintenance carried out on the installed site.</b>  4.1 <u>List of tasks</u> ;  4.2 <u>Tools and materials</u> ;  4.3 <u>Maintenance tasks</u> .  Comprehensive step by step instructions in preventative and corrective maintenance procedures, nominating the work to be carried out by qualified tradespersons and others <ul style="list-style-type: none"><li>• Safety procedures</li><li>• Maintenance standards</li></ul> Maintenance instructions for each of the service periods.  Location of maintenance action (on-system, workshop etc).  Consumables and special tools required.  List of recommended greases and oils, stating quantities, methods and frequency for application.
<b>Section 5</b>	<b>Fault diagnosis</b>  Describe a series of sequential actions to diagnose equipment faults. It is important that the operational requirements are included in these sequences. Troubleshooting instructions in tabular form listing “fault”, “possible cause” and “remedial action”, with testing regimes and instructions.
<b>Section 6</b>	<b>Removal and Installation</b>  Describes procedure for transport, installation, commissioning or removal of the equipment or components. It shall include information on support equipment, packaging, handling, transport and storage requirements.

<b>Section 7</b>	<b>Overhauling</b>  Step by step instructions and procedures for complete overhauls, indicating those procedures to be carried out by qualified tradespersons, described under at least the following subheadings:  Material safety data Sheets  Handling precautions  Dismantling  Cleaning, Inspection, Repair and Adjustment  Reassembly  Final Checks and Unit Running
<b>Section 8</b>	<b>Spare Parts</b>  Data on spare parts supplied under the following headings:-  “List of Suppliers”, stating:  Manufacturer  Manufacturer’s nearest representative  Company address  Telephone and Facsimile numbers  “Illustrated Parts List”, including:  A list (or lists) of parts with part numbers referenced to an illustration, preferably an exploded view of sectional drawing and a specification  “Recommended Spare Parts”, including:  The list of recommended spare parts with part numbers and quantities and a separate list of spare parts supplied under this Contract to the Principal’s Representative  “Availability of Spare Parts”, including:  A short statement quoting the worst case procurement lead time/availability to suit the quantities of parts from suppliers  “Ordering Information”, including:  Specific details that would be required when ordering replacement parts, such as serial number, model number, name, reference number and the like  “Special Tools”, including:  A list of any special tools required when for periodic maintenance or overhauls

<b>Section 9</b>	<b>References</b>  Summary tabulation and details of all applicable Certificates, Warranties and Guarantees related to the asset with cross reference to the location of the originals.  (Originals of all Certificates, Warranties and Guarantees must be provided as handover documentation, in a logical grouping for particular assets, labelled in such a manner as to provide traceability.)  Tabulation of Consultants, Sub-Consultants, Service providers, Suppliers and other Subcontractors and utilities/service providers, together with contact details for each significant element of the assets.  Reference to all commissioning records/results and reports.
<b>Section 10</b>	<b>Quality Records</b>  This section shall provide details and the respective forms (where required) of all records that are required for maintenance and breakdown actions. These shall be presented in tabular form, and sample forms produced one form per page in the manual.  Each form shall be delivered in a separate file of native format (eg. MS Word or MS Excel)
<b>Section 11</b>	<b>Test Certificates</b>  All works and site test/commissioning certificates for the system/ subsystem and equipment shall be included in this section.
<b>Section 12</b>	<b>Hard copy of Work-as-Executed Drawings</b>  This section shall include a complete list of the drawings associated with the manual. The PDF version of the manual shall link to a PDF or TIFF copy of the each corresponding drawing.

#### 3.4.4 Validation of Content

The operations and maintenance documentation provided must be validated prior to commissioning and used as part of the training provided by the OEM.

### 3.5 Training

#### 3.5.1 Training Requirements

A training program shall be developed, provided and implemented. This shall cover each part of the equipment as specified by the RFT and address the following issues for each training course:

- specific training objectives;
- training methods for the operation and maintenance personnel;

- training documentation, aids and material necessary to support the training;
- training syllabus, course outlines, training notes, content plans, in the form of a training manual, meeting the defined training course objectives;
- cover both operations and maintenance requirements including testing and operational evaluations.

The training shall be designed for appropriately qualified personnel requiring only specialised training required on the relevant systems.

The training shall be conducted only by persons who are appropriately skilled, qualified, experienced and competent in the field involved, and who have completed formal training in instruction techniques.

All training aids and material must be up to a good commercial standard and appropriate for the training to be conducted.

Training may be conducted on a site where the equipment is installed or off-site. The required location for training will be stated in the RFT.

Where training is to be conducted off-site and access to particular equipment is required, training must be undertaken on equivalent duplicate equipment to that installed on ARTC's network. Off site training must be supplemented with visits to the applicable installed system on the Site. If no location for off-site training is specified in the RFT, off-site training shall be provided in Sydney.

### **3.5.2 Operator Training**

The training program shall cover and address operations and site familiarisation training for electrical operators who will be required to operate, isolate and earth electrical equipment:

The operator training shall be designed for persons qualified under the ARTC Electrical Safety Instructions and experienced in the operation of existing electrical High and Low voltage infrastructure that is part of the Sydney railway network.

The training shall include the:

- theory and practice of the operation of the equipment and its constituent parts and systems;
- controls and instruments;
- safety and emergency operations; and
- techniques for checking, testing and adjusting systems.

### **3.5.3 Maintenance Training**

Specific maintenance training shall be included for personnel responsible for:

- routine examination and servicing;

- repair systems, including the temporary and permanent repair of damage caused through vandalism, collision or other unscheduled event; and
- specialist processes such as on site fault finding, removal and replacement, functional or operational testing to a level necessary to support the systems involved.

Maintenance training shall include familiarisation with the equipment, and the specific maintenance requirements for all system, subsystem and ancillary equipment arrangements.

Maintenance training shall also cover the engineering management of the systems for engineering staff.

### **3.6 Facilities, Equipment and Special Tools**

A list of special tools, facilities and equipment necessary for the operation and maintenance of the systems shall be developed and provided.

The list shall:

- include the recommended number of special tools, facilities and equipment required for the operation and maintenance of the equipment;
- identify the items required to perform specific maintenance, repair and recovery tasks on the equipment, including scheduled preventative maintenance of the equipment, the removal, installation and testing of rotatable and repairable items, and other procedures, such as temporary repairs during normal operating periods for unscheduled failures with follow-up maintenance and emergency recovery; and
- include any special purpose test equipment and facilities needed in support of the maintenance tasks, including specialist hand-tools.

This list of special tools, facilities and equipment must include:

- details of, and a specification for, each item;
- purpose of the item;
- maintenance requirements for each item,
- supplier;
- the quantity required;
- price and validity period expected;
- packaging, storage and handling requirements; and
- delivery times.

## Appendix A Technical Schedule

The Tenderer shall supply the information listed in this Technical Schedule at tender stage. This information will be used as an aid to assess the life cycle cost of each tender and to confirm that tenderers understand the importance of the integrated support requirements in the procurement process.

### 3.2.1 Scheduled Maintenance

Provide details of a preliminary scheduled maintenance list including methodology for this list.

### 3.2.2 Maintenance Requirements Analysis (MRA)

What analysis and documentation tools are to be used?

ARTC templates or OEM's in house software

If OEM's in house software is used please provide details of documentation and past usage.

Provide details of experience with MRA/RCM analysis and documentation.

### 3.2.3 Failure Modes, Effects and Criticality Analysis (FMECA)

What method of FMECA will be used?

ARTC templates or OEM's in house software

If OEM's in house software is used please provide details of documentation and past usage.

What is the source and extent of the data used in the FMECA – provide detail.

Is the FMECA based on operational experience – provide detail.

### 3.3.1 Spares Assessment Methodology

What methodology for spares assessment will be used?

Please provide details of documentation and past usage.

Provide details of a preliminary spares list including methodology for this list.

### 3.3.3 Packaging, Storage and Handling

Any special requirements for packaging, storage and handling for the equipment or recommended spares to be provided.

### 3.4 Operation and Maintenance Manual

What format are the manuals to be supplied?

Microsoft Word97 format or OEM proprietary format modified to meet all requirements of section 3.3.3 of this standard.

If OEM's format is used please provide details of documentation and past usage.

### 3.5 Training

Please provide details of anticipated delivery method, location, qualifications (technical and training) of personnel and list of resources.

## Appendix B Request for Tender (RFT) Checklist

### General

Where this standard is used as a supporting document for the integrated support requirements for the procurement of a major item of electrical equipment, the following information must be considered for the particular situation, and provided to the tenderers if required. All the items listed in this document may not be required. The Request for Tender must be specific in highlighting which clauses are mandatory, which clauses are optional and which clauses can be deleted. The following issues must be considered in making these determinations for each RFT:

- Previous usage of identical or similar equipment in the ARTC network;
- The number of items of equipment; and
- The planned geographical spread of the equipment in ARTC network;
- The complexity of equipment;
- The cost of equipment;
- The cost of the total order.

### Maintenance Requirements

The RFT must indicate that the equipment supplier must provide all of the information set out in clause [3.2 Maintenance Requirements](#).

The tenderer should also be made aware that if they are successful they must submit the FMECA at least 28 days prior to the delivery of the equipment;

### Spares Support

The RFT must indicate that having completed the spares assessment methodology of clause [3.3 Spares Support](#) the equipment supplier must provide the Recommended Spares List as set out in clause [3.3.2](#).

The tenderer shall provide a preliminary spares list, refer to Appendix A [Appendix A Technical Schedule](#) both in the equipment standard for the particular item of electrical equipment and this document.

The decision for the procurement of spares is an iterative process and should be addressed as such by the RFT. Once the successful tenderer has provided the detailed spares list (which should be consistent with the original proposed spares list provided as part of the tender) and methodology, a ARTC representative must then review the life cycle cost analysis in conjunction with the existing ARTC spares. Note that it is a ARTC responsibility to determine the system spares policy.

### Packaging, Storage and Handling

The RFT must indicate that the equipment supplier must provide all of the requested information in clause [3.3.3](#)

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## Operation and Maintenance Manual

The document number, as described in clause [3.4.2.1 Document Numbering](#), must be supplied to the successful tenderer.

The successful tenderer must:

- submit two unbound draft hard copies of the Operations and Maintenance Manual at least 28 days prior to the delivery of the equipment;
- ensure the draft manuals must meet all the formatting requirements of clause [3.4](#)
- act on comments made on, and correct deficiencies in, the draft copies and supply the final bound hard copy sets and electronic sets incorporating all the changes needed by the equipment delivery date;

The number of hard copies of the manual shall be a minimum of five (5) (or 1 each location if required, 1 each field engineering office, 1 for Design) and the number electronic versions on CD shall be two (2) (or 1 each field engineering office, 1 for Design). The RFT must specify total hardcopy required.

## Training

For the tenderer to determine the training requirements of clause [3.5 Training](#), the tenderer must be informed of the number of staff nominated for each type of training.

The RFT must indicate that the equipment supplier must provide the training program and training manual for review at least 28 days before any training takes place.

The RFT must nominate location for on-site, and off-site training to be delivered. Refer to clause [3.5.1](#).

- **Facilities, Equipment and Special Tools**

The RFT must indicate that the equipment supplier must provide the list of special tools, facilities and equipment as set out in clause [3.6](#)

A final list of special tools, facilities and equipment shall be submitted not later than 28 days prior to delivery of the first installation or in sufficient time for essential items to be available for use with training, whichever is the earlier.

The RFT must specify details of the process to procure the range of special tools, facilities and equipment required following the submission and review of the recommended list. Refer to clause [3.6](#).

The RFT must indicate that the tenderer must provide a preliminary list of special tools, facilities and equipment with the tender.

- **Quantity and Costing of Integrated Support Deliverables**

The RFT shall state the quantity of each deliverable required and request a breakdown of the cost for the various items to facilitate the full life cycle cost

analysis. The list of deliverables to be costed shall include:

Provision of Operations and Maintenance manuals in accordance with clause 3.3.3; Provision of training aids and material for the Principal's use in undertaking future training.

Provision of training in accordance with clause 3.5. The training costs are to be broken down into separate costs for Operator Training and Maintenance Training.