METERING ASSET MANAGEMENT PLAN

MDM 0002

2017/2018

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Document Control

Version	Date	Comments
Ver. 1	Apr. 2008	Originally developed to cover testing, inspection and replacement of all Metering Assets
Ver. 2	Aug. 2009	Reviewed to take into account the cutback in meter replacement program and introduce LV CTs' testing by sampling
Ver. 3	Sep. 2010	Revised to examine the replacement program on the basis of in-service compliance testing in view of discussion with AEMO; and testing of LV CTs.
Ver. 4	May 2012	Reviewed according to annual MAMP review process as per AEMO's acceptance condition and incorporated LV CT test plan developed in accordance with the AER *compliance bulletin No.6* and AEMO document: *Alternative Testing Minimum Requirement: LV CT Metering Installations (V1.0).*
Ver. 4.1	Nov. 2012	Revised the LV CT test plan based on the comments and clarification provided by AEMO and AER. Revised the MAMP only to accommodate the obligation for Endeavour Energy Network as RP.
Ver. 5	July 2013	Reviewed as per annual MAMP review process for financial year 2013/2014. LV CT test strategy is to test a second sample size of 10% of total CT premises in 2013/2014 based on the assumption that AER's directive will be to continue same as in financial year 2012/2013.
Ver. 6	May 2014	Reviewed as per annual MAMP review process for financial year 2014/2015.
Ver. 7	Aug 2015	Reviewed as per annual MAMP review process for financial year 2015/2016.
Ver. 8	June 2016	Reviewed as per annual MAMP review process for financial year 2016/2017.
Ver. 9	July 2017	Reviewed as per annual MAMP review process for financial year 2017/2018.

Document Review

Ver. 9 July 2017	**Prepared by**:	Zahid Syed, Metrology Engineer, Metering, AMD

Executive Summary

The Metering Asset Management Plan (MAMP) has been developed to address Endeavour Energy metering asset strategy in accordance with policy 9.6.6 'Metering Assets', and comply with regulatory obligations. This plan is the current update of the yearly MAMP, rolling over 5 years and addresses Endeavour Energy's obligations as an RP within the National Electricity Rules (NER). This MAMP commences from the start of the 2017/2018 financial year.

Endeavour Energy has over 1.53 million meters installed at Type 5-6 connections on its network.

The plan is based on the *National Electricity Rules* and covers:

a) Test plan for meters and measuring instrument transformers;
b) Inspection of metering installations; and
c) Meter replacement program on the basis of population failures for in-service compliance testing.

The current review is part of the annual review process of the MAMP and also incorporates a strategy to continue the testing of LV CTs in Endeavour Energy Network as per *AER compliance bulletin No.6* and AEMO document: *Alternative Testing Minimum Requirement: LV CT Metering Installations (V1.1).*

Appropriate resources and funding via Endeavour Energy's capital and operating budgets are validated regularly to operate the plan.

The executive authority to implement the plan lies with the Manager, Asset & Metering Data and the General Manager, Asset Management in accordance with Endeavour Energy's delegations of authority.

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Table of Contents

1 Purpose

The National Electricity Rules *(Rules)* made under the National Electricity Law require that the Responsible Persons (RPs) have in place both an Asset Management Strategy and Test Plan for installed metering assets. The Endeavour Energy Metering Asset Management Plan has been created to incorporate both of these requirements.

2 Scope

This MAMP applies to the following classifications of Metering Installations as defined in Chapter 7 of the *Rules* and the *National Metrology Procedure*:

a) Type 5 Metering Installations: Meters and Current Transformers where Endeavour Energy (EE) is RP (where applicable)

b) Type 6 Metering Installations: Meters and Current Transformers (where applicable)

The metering assets stated above are associated meters and CT assets owned by Endeavour Energy.

This MAMP does not intend to cover the obligations as a Meter Provider (MP).

The *Rules* delegate the *Responsible Person* (RP) role to the respective LNSP (Local Network Service Provider) for:

- Type 5 meters where Endeavour Energy[1] is RP
- Type 6 Metering Installations within Endeavour Energy's Distribution System

[1] Endeavour Energy, AMD registered with AEMO as national MP and MDP.

3 Outline of the Plan

The detail of this plan reflects the Metering Asset Management Strategy and consists of the following sections.

3.1 Compliance with the MAMP for 2016/2017

Assesses the compliance of the 2016/2017 MAMP against the approved position.

3.2 Testing and Inspection of Metering Installations

Details regarding the testing and inspection of metering installations are provided in the sections listed below:

- Testing Process (section 9)
- Meter Test Plan (section 10)
- Inspection Plan (section 11)
- Instrument transformer Test Plan (section 13)

3.3 Meter, CT Testing and the Asset Replacement Program for 2017/2018

The volume of work to be undertaken is summarised below in Table T1.

TABLE –T1

Network	MI Type	Plan	17-18	18-19	19-20	20-21	21-22
Meter Test & Inspection Plans		**Carry over from 2016/2017**	**96**				
EE Network	Type 5 & 6	Sample Test/ Site Inspection	540	340	350	225	1240
Total Sites (Meter Testing & Inspection)			**636**	**340**	**350**	**225**	**1240**
LV CT Testing	Type 5 & 6	**Carry over from 2012 to 2017**	**117**				
EE Network **(NOTE 1)**			407	387	367	349	332
Total Sites (LV CT Testing)			**524**	**387**	**367**	**349**	**332**
Total Yearly Sites to Visit for Tests & Inspections			**1160**	**727**	**717**	**574**	**1572**
Asset Replacement Plan							
EE Network **(NOTE 2)**	Type 6	Bulk Meter Change Sect 12	1000	41918			
Total (Asset Replacement)			**1000**				
Total Yearly Sites to Visit			**2160**	**727**	**717**	**574**	**1572**

Note 1: The forecast for LV CT testing reduces by 5% per year taking into account the estimated reduction to the meter population due to Power of Choice. FY 17-18 has additional tests in order catch up on the carry over.
Note 2: Power of Choice commences on 1 December 2017. From this date Endeavour Energy will provide Retailers/Meter Providers with a list of meter types that do not meet the metrology requirements and the Retailer/Meter Provider has the responsibility to replace these with Type 4 smart meters as a priority.

Number of In-service Compliance tests due in 2019/20 is 690. This has been split across 2018/19 and 2019/20 as best fit with meter types to assist resource levelling.

4 Compliance of 2016/2017 MAMP

The progress of meter in-service Compliance 2016/2017 is shown below. The remaining 3 types of population compliance tests will be included in the next financial year 2017/2018 to complete the compliance for 2016/2017.

Test Plan & Progress for In-Service Compliance 2016-2017 (MT03)

Pop Code Description	Sample Size May 2016 (to be tested)	Total Tested	Carry over to 2017/2018	Compliance Status	Next Test Due	%Completion
HMT 1p WC	75	**38**	37	In progress carry over 2017/2018	21/22 if all pass	51%
SD 3p WC Over 6 Series	100	**46**	54	In progress carry over 2017/2018	21/22 if all pass	46%
A11 1p WC	75	**62**	13	In progress carry over 2017/2018	24/25 if all pass	83%
M1 1p WC 1981-1985	150	**150**	0	Completed - Passed	24/25	100%
A1K 3p LVCT (+ In Service test)	15	**15**	0	Completed - Passed	20/21	100%
SDM 3p LVCT (+ In Service test)	50	**50**	0	Completed - Passed	21/22	100%
EMS 1p WC (Nilsen)	75	**75**	0	Completed - Passed	21/22	100%
K410 3p WC (Enermet)	75	**84**	0	Completed - Passed	21/22	112%
Q3 3p LVCT (+In Service test)	15	**15**	0	Completed - Passed	21/22	100%
	630	**534**	96			85%

The tables below provide a summary of the LV CT testing progress since 2012

CT Population where EE is the RP

Group No	Model Type Description	2012-13	2013-14	2014-15	2015-16	2016-17
1	Type A 150/300/600/5 CT	198	198	198	199	190
2	Type B 200/400/800/5 CT	156	156	155	155	150
3	Type B 400/800/1200/5 CT	64	64	64	53	50
4	Type C 1000/2000/3000/5 CT	2	2	2	2	2
5	Type S 200/5 CT	3556	3556	3539	3426	3335
6	Type T 800/5 CT	347	347	342	337	325
7	Type W 1500/5A CT	19	19	19	20	20
	Grand Total	**4342**	**4342**	**4319**	**4192**	**4072**

10% of population

Group No	Model Type Description	2012-13	2013-14	2014-15	2015-16	2016-17
1	Type A 150/300/600/5 CT	20	20	20	20	19
2	Type B 200/400/800/5 CT	16	16	16	16	15
3	Type B 400/800/1200/5 CT	6	6	6	5	5
4	Type C 1000/2000/3000/5 CT	0	0	0	0	0
5	Type S 200/5 CT	356	356	354	343	334
6	Type T 800/5 CT	35	35	34	34	33
7	Type W 1500/5A CT	2	2	2	2	2
	Grand Total	**466**	**440**	**440**	**435**	**413**

Actual tests

Group No	Model Type Description	2012-13	2013-14	2014-15	2015-16	2016-17
1	Type A 150/300/600/5 CT	42	42	39	20	1
2	Type B 200/400/800/5 CT	36	53	11	19	0
3	Type B 400/800/1200/5 CT	19	7	3	7	4
4	Type C 1000/2000/3000/5 CT	2	-	-	-	-
5	Type S 200/5 CT	333	331	378	357	220
6	Type T 800/5 CT	34	37	14	32	22
7	Type W 1500/5A CT (Note 1)	-	-	-	-	-
	Grand Total	**466**	**470**	**445**	**435**	**247**

Variance

Group No	Model Type Description	2012-13	2013-14	2014-15	2015-16	2016-17	Sum of variance
1	Type A 150/300/600/5 CT	22	22	19	0	-18	**46**
2	Type B 200/400/800/5 CT	20	37	-5	4	-15	**42**
3	Type B 400/800/1200/5 CT	13	1	-3	2	-1	**11**
4	Type C 1000/2000/3000/5 CT	2	-	-	-	-	**2**
5	Type S 200/5 CT	-23	-25	24	14	-114	**-122**
6	Type T 800/5 CT	-1	2	-20	-2	-11	**-31**
7	Type W 1500/5A CT (Note 1)	-	-	-	-	-	**0**

Note 1: Type W less than 10 years old therefore not due for testing

The variance to the required 10% of tests is shown in the table above. The total variance in the actual number of tests from 2012 to 2017 is identified in the column on the right. Where the sum of the variance is positive Endeavour Energy is ahead of the 10% testing requirement and negative Endeavour Energy is behind the 10% testing requirement.

To date there have not been any failed CTs since 2012.

5 Summary of Metering Installations Assets

Table T2 provides a summary of the overall population of metering assets at both high voltage and low voltage installations.

TABLE – T2

MI Category		MI Type[2]	CT Meters		WC Meters	Total
			HV	LV		
MRIM	EE Network (RP)	5		232	480	712
Basic (Accumulation)	EE Network (RP)	6		3,398	1,531,347	1,534,745
Grand Total		**5-6**		**3,630**	**1,531,827**	**1,535,457**

Note: Metering assets on the EE Network exclude meters installed in transmission and zone substations as these are non-market assets and are used for statistical metering.
The data is current as of June 2017.

- All Type 5 installations are read remotely to facilitate operational requirements.
- For Type 5 meters, Endeavour Energy has engaged an accredited external meter provider to provide metrology requirements and services for MP, MDP, MPC roles, and are excluded for the purposes of the MAMP.
- Type 6 installations are low voltage installations and have either electronic or disc (Ferraris) type accumulation meters.

The majority of the meters installed are mainly from the following manufacturers and the commonly used models /designs are:

- Landis & Gyr - CM170, ZMD11, (Ampy / Email) Q3, Q4, EM5300, A1R/K-AL, E1RL, A11, EM1000, E1210/12/2B, EM333B, P1 & EM500
- EDMI - MK3, MK6, MK6N, MK10, MK7
- Secure PRI - EMS Nilsen, CALMU, Sprint
- Echelon - EM1021, EM1023
- Itron - A1000 (Actaris)
- Elster - A1100

[2] For testing and inspection purposes, Metering Installation types defined in Rules Schedule 7.2 and Metrology Procedure Part A 2.4.16 & 18 are based on annual energy consumption are as follows:
Type 1 (> 1000 GWh), Type 2 (100 – 1000 GWh),
Type 3a (10 - 100 GWh), Type 3b (2 < < 10 GWh), Type 3c (0.75 - 2 GWh),
Type 4 (0.16 < < 0.75 GWh), Type 5 (< 0.16 GWh) and Type 6 (< 0.10 GWh)

6 Resources and Test Capability

AMD in-house Metering Laboratory and Workshop at Huntingwood are equipped with the requisite Testing and Calibration Standards as well as Test Benches for testing and re-verification of removed meters and CTs.

CT & VT standards are available to test the HV & LV CTs & VTs in the field and in the workshop. All the measurement and testing standards are calibrated at regular intervals at NATA accredited laboratories. Calibration traceability records are maintained for all testing instruments and standards. (See *Annexure A*)

The resources to complete the meter testing, CT testing and meter replacement program (See *Annexure E*), consists of competent and experienced metering technicians, specialists, engineers and managers as follows:

- Meter Technicians (7) for inspection, testing and commissioning of meters and LV CTs;
- *Engineering Officer – CT testing* for testing LV CTs and the management of the LV CT testing requirement of the MAMP;
- *An Outsourced Service Provider* conducts the replacement of type 6 WC meters. At the start of PoC this contract will cease and responsibility will be handed to the Retailers to manage;
- *Engineering Officer – Meter Lab* for testing and re-verification of meters, current transformers and testing equipment; also capable of programming Interval meters and responsible for in-situ testing of LV and HV metering installations;
- *Supervisor Workshop* for testing of metering equipment both in the field and the workshop including programming interval meters and operational management of the Metering Laboratory and Workshop;
- *Metrology Engineer - Metering* for test design, analysis, and project support;
- *Business Analysts* for development of the MAMP related processes with asset/data information and specialised IT support;
- *Operations Manager* for the operational management of the MAMP both for EE network, including in-service compliance testing and meter replacement program;
- *Metering Asset Engineering Manager* to oversee the MAMP formulation including review as required;
- *Back office admin staff* for updating the database records for organising & issue of various job orders, storage of tests results for new and refurbished meters and CTs/ VTs, and general administration work; and
- *Manager, Asset & Metering Data*; executive authority to implement the MAMP with the appropriate resources and funding through capital and operating budgets.

7 Financials and Corporate Policy

In accordance with the EE Guidelines for the Preparation of the Metering Asset Management Plan, NMT 8009, Table T1 details the entity responsible for the maintenance and testing of Type 1-6 metering installations. This procedure is maintained as part of the Company's Business Management System (BMS).

Item	Maintenance/ Testing Entity Responsible
1) Metering Installation Types 1- 4	Responsible Person (RP)
2) Metering Installation Type 5 (<160 MWh)	Company Network/Asset and Metering Data Branch (where contracted)
3) Metering Installation Type 6 (<100 MWh)	Company Network/Asset and Metering Data Branch (where contracted)

A provision for the necessary funds for asset replacement, testing and inspection is made in the EE/AMD annual Capex and Opex budgets as detailed in the table below.

Service	Budget
In service meter compliance testing (MT03)	$150k
In service CT compliance testing (MP22)	$130k

8 MAMP Review Period

A process has been setup for the MAMP to be reviewed annually to reflect the change in assets in the franchise area and compliance status.

The updated MAMP for the next financial year will be submitted to AEMO for approval.

In addition, this review includes our LV CT test strategy to test the 10% sample of total CT premises in the Endeavour Energy network for FY17-18 as per *AER compliance bulletin No.6* and AEMO document: *Alternative Testing Minimum Requirement: LV CT Metering Installations (V1.1)* based on the assumption that AER's directive will be the same as the previous financial year.

9 Testing Process

9.1 General

The purpose of the testing is to test the metrological functions and determine the error performance of meters and instrument transformers.

Measuring Instrument transformers consists of HV VTs & CTs for high voltage installations and LV CTs for low voltage installations. The HV VTs & CTs are tested for Ratio Error and Phase-angle Error as per Rules requirement, in accordance to their Standard[3] of manufacture, and LV CTs are tested to AS 60044.1:2007 as per AEMO document: *Alternative Testing Minimum Requirement: LV CT Metering Installations (V1.1).*

Overall error for the metering installations will be performed in accordance to the rules requirements.

9.2 Testing Location and Assumptions

CT and WC Interval meters are either tested in-situ or removed for testing in the Metering laboratory or returned to the manufacturer as required.

Interval meters which have been programmed for TOU or are used as accumulation meters are tested as Interval meters.

9.3 Summary of Test Points

Annexure B outlines the meter test points and error limits described in the Rules, National Metrology Procedure and the respective Australian Standards (AS62053.11, AS62053.21 and AS62053.22). The meter current injection test points are different, depending on whether the meter test is for the Rules/ Metrology Procedure or for In-Service Compliance Testing (AS1284.13:2002).

CT and WC meters are to be tested to the respective criteria listed in *Annexure B.*

9.4 Meter Age

'Meter age' refers to years in-service since commissioning. Time reference in relation to the age of a Metering Installation is taken as the *'Installation date'* of a meter. It is generally the case that a meter has been installed within 6 months of its manufacture and purchase or last test date. For a population of new meters the compliance period is 10 years.

9.5 Meter Verification

New meters are supplied with reports of initial verification tests performed by the manufacturer. All new meters have pattern approval certificates from NMI and the meters are verified by a Utility Meter Verifier as per NMI NITP14. All new meters procured are sampled for an Acceptance inspection in batches in accordance with IEC 62058-31. No removed meter is re-used without having been re-verified, either by AMD or by the respective manufacturer or a third party.

9.6 Testing Uncertainty

The Expanded Uncertainty for each measurement is estimated at the 95% confidence level and these are maintained within the limits of NER Schedule S7.3.1.

[3] CTs - AS1675-1986, AS 60044.1:2007

VTs - AS 1243-1982, AS 60044.2:2007, AS 60044.3:2004 and AS 60044.5:2004 for CVTs

9.7 Statistical Sample Testing

Sample Testing of Meters

AS1284.13:2002 '*In-service compliance testing*' provides an economical method for testing a large population of meter groups for both CT and WC meters except when the population of meters is considered to be *Small* (Refer 8.6.2) . This technique is based on a statistical sampling method using the variable option (where normal distribution has been established) or by using attributes testing and is used to determine if populations of meters comply with the required metrological performance.

WC and CT meters at Type 6 (EE as RP) connections are included for sample testing (*Annexure C*)

Annexure C shows population groups for Type 5 and Type 6 meters with their respective sample sizes as at May 2017. The meter family groups have been reviewed and are based on the manufacturer, meter model/design or pattern (electronic or induction), number of phases and CT/WC connection. The sub family population that have failed in the past have been excluded from the main family groups. There are currently 76 groups giving a total sample of 4149 meters representing the entire population of 1.53 million Type 5 and Type 6 meters.

The testing criteria outlined in AS 1284.13:2002 specifies periods for re-test (also termed "compliance period") which are determined from the test results analysis. If a sample of the population cannot meet the requirements, then the population will be divided into sub populations for retesting. If a sub population of meters does not meet the requirements, then that sub population will be failed and included in the Meter Asset Replacement program and resources allocated in accordance with the relevant priorities at that time.

According to the standard AS1284.13:2002, all new design/pattern meters are tested within three years of their installation date to determine the initial *in-service compliance period* (refer Table 4 of AS1284.13:2002). Meters either in service for over 15 years or out of the *initial in-service compliance period* are sample tested to determine the *on-going in-service compliance period* (refer Table 5 of AS1284.13:2002). If the on-going in-service compliance period for re-testing of a meter population is calculated to be 2 years or less, then that meter population will be replaced where it is not economic to continue re-sample a very small sub population.

Section 11 of the document provides the meter replacement plan in detail.

In-service compliance testing began in March 2003. Since the total meter population is varying continuously, the Table in *Annexure C* is updated yearly to validate the sample sizes for compliance testing during the next financial year.

Small Family Size

Endeavour Energy currently considers populations less than 25 meters as 'Small' and these populations will be 100% tested or replacement, based on the Meter Age.

If less than 25 replace as per BMR dependent on cost.

10 Meter Test Plan

10.1 Power of Choice Impact on CT Testing

After the introduction of Power of Choice, once a smart meter is installed on a site that has CTs, the CTs are gifted to the meter provider and the meter provider is responsible for the metrology compliance of the CTs from the meter change date.

10.2 CT and WC Interval and Accumulation Meters

All CT and WC interval and accumulation meters at Type 5 and Type 6 to be tested on a sampling basis using the variable testing option as per AS 1284.13:2002. A total of 540 randomly selected meters will be tested in addition to the carryover of 96 meters in FY17-18. These cover 14 different meter models at single and three phase WC/CT sites.

Annexure C provides the population groups with their corresponding sample sizes, the status of the In-service Compliance Testing to date, and the plan for sample testing going forward.

10.3 Test Plan

Annexure E summarises the test volumes required to comply with the above criteria.

11 Metering Installation Inspection Plan

11.1 Inspection Schedule

Type 6 installations are inspected at the same time as when the meters are tested.

Annexure E summarises the inspection volumes required to meet the NER requirements.

11.2 Inspection Process

The inspection process for high voltage and low voltage metering installations include the in-service tests[4] as specified in AMD workplace instructions for the respective HV (WMT1565) & LV (WMT1564-CT, WMT1566-WC) installations.

These in-service tests will also incorporate the information gathering process to facilitate the population of a database of information relating to all installed LV CTs.

Inspection process includes appropriate checks of the meter board equipment.

[4] In-service test includes checks on CT ratio, in-service burden, and element check and demand calculations. Vector diagram and register checks are also performed.

12 Asset Replacement Program

12.1 Power of Choice Impact on Asset Replacement Plan

After the start of Power of Choice on 1 December 2017, Endeavour Energy will notify the retailers at the start of every financial year via a B2B meter fault notification of the specific NMIs, where they are the retailer, which have a meter on the bulk meter replacement. Each retailer will be responsible for managing the replacement of these meters with smart metering. If a retailer changes a new MFN will be sent to the new retailer.

12.2 Sample Based

Type 5 and Type 6 meters will be replaced based on In-Service Compliance Testing results as outlined in section 8.6.

The sample testing for Type 5 and Type 6 meters (*Annexure C*) has been reviewed and decisions made about failed populations in the Meter Replacement Plan part of this MAMP (*Annexure E*).

If the status of meter population groups is found non-compliant after sample testing, the failed populations will be sub divided into sub families based on the purchase year as per AS1284.13:2002 (This standard allows a large population to be divided in to sub-population groups). If these sub family populations fail, they will be replaced. . Annexure C shows the meter replacement plan which includes all the meter types either failed in service compliance or unidentified meter types.

12.3 Meter Failures during On-site Testing

In cases of on-site testing, any meter which *'fails'* on-site testing is replaced immediately, whether the test has been at the request of a customer, as part of Asset Management Plan maintenance, or for in-service compliance purposes. These failures are monitored for further investigation. After the start of Power of Choice the meter failure will be raised with the retailer through a B2B meter fault notification.

12.4 Meter Failures due to Faulty Displays

During sample testing in 2011, a number of ZMD three phase WC meters were found to have faulty displays. Further investigation has shown that the root cause of the failure was caused by power outage which resulted in the meter not powering back up after being reconnected to the voltage supply. The metrology performance of the meter was tested and deemed to be acceptable at the time. Subsequently, a significant number of faulty meter replacements have been ZMD meters; therefore a decision has been made to include these to the meter replacement program.

12.5 Meter Failures due to Unidentified Meters

Illawarra electricity had unidentified meters when it was amalgamated with Prospect electricity. These unidentified meters exist in Endeavour Energy systems however the meter details such as the meter type are not known.

Initially, this group comprised of 80,287 meters. Endeavour Energy has identified or replaced 75,505 of these however the remaining 4,782 will be included in the meter replacement program.

All of the meters are located in the Illawarra region and were installed before 1996, therefore greater than 21 years old.

12.6 Meter Failures due to Excess Consumption

From the start of PoC, when a customer exceeds the Type 6 or Type 5 consumption threshold a Meter Fault Notification will be sent to the retailer via a B2B transaction.

13 Testing of Instrument Transformers

13.1 HV VTs & CTs

Currently Endeavour Energy is not RP for any HV connections.

13.2 LV CTs

Testing Strategy – Sample Testing of LV CTs

Endeavour Energy will test a 10% representative sample of all LV CTs per financial year from the identified family types, for Type 5 and 6 metering installations, where EE is RP. These samples will be tested as per AER Compliance Bulletin No.6 – December 2011. The FY17-18 sample will be selected from the CTs due for testing by 30 June 2018, where records of historical test results for the last 10 years are not available. When EE visit a premise and identifies CTs with an unknown installed date they will be tested. All CTs at a premise will be tested, while assuming all CTs at a premise are of the same family and installed in the same year. Representative sample groups have been defined in terms of CT Type.

Annexure D shows family types with their respective sample sizes for LV CTs at Type 5 & 6 premises in the Endeavour Energy network that will be tested by the end of FY17-18 and number of CT Premises that were tested during FY12-13, FY13-14, FY14-15, FY15-16 and FY16-17 (In Progress). These are divided into 7 groups, resulting in a total sample of 410 premises representing the entire CT population of 4180 premises. All CTs found at nominated premises will be tested.

Endeavour Energy shall ensure all new CTs are tested and any CTs removed from service are tested before being reissued for installation.

Testing Frequency

The sixth round of LV CT testing, using the 10% sample testing method will run 12 months starting 1st July 2017, and will be completed in accordance with AER Compliance Bulletin No.6 - December 2011.

Test Points and Test Burdens

Annexure B outlines the test points, test burdens and error limits (as per AS 60044.1). All LV CTs (including multi taps and extended range) shall be tested in-situ at 25% rated burden, at unity power factor, after demagnetising in accordance with AEMO document: Alternative Testing Minimum Requirements: LV CT metering installations (V1.1).

13.3 Testing Methodology

There are three different testing methodologies for LV CTs which are detailed below:

- The conventional *Primary Injection* (PI) technique, whereby a test current is applied to both CT under test and a calibrated reference CT, then comparison is made between the two outputs using a calibrated Comparator. The error limits generally refer to the relevant Australian Standard (AS) of manufacture. The test is repeated for a range of test currents. This work requires a customer outage and safe access to the LV conductors. Primary Injection cannot always be carried out because access to the primary CT terminals is not always physically possible.
- The *Secondary Voltage Injection* (SVI) technique, whereby a voltage representing a specific load condition of the CT secondary winding is applied to the open-circuit secondary terminals, with the primary circuit unburdened. Measurements are made and the values inserted into spreadsheet formulae which calculate *errors* that reflect the *Primary Injection* errors, but are not identical to them. The SVI method is applicable to both HV and LV CTs. However, it cannot be used for CTs that have turns compensation. A very distinct advantage of SVI is that it can be carried out in a short time (typically 5 -10 mins) as no access to the primary circuit and no heavy equipment is required.
- Using proprietary CT testing equipment, i.e. Red phase Instruments. CT tests are performed by measuring turns ratio and 50Hz admittance of a CT's secondary winding. The test measure the performance of the CT while out of service for only a few minutes and automatically calculate the error to typically within 0.02% accuracy for desired percentage of rated current, at the required power factor. This is the Endeavour Energy's preferred method for in-situ testing of LV CTs.

Endeavour Energy use the proprietary CT testing equipment for all testing.

14 Management of Test Equipment

AMD Metering Laboratory and Workshop are equipped with Test benches, Testing equipment and Reference Standards which are used to determine the *errors* associated with the use of meters, CTs and VTs installed at Metering Installations.

- Primary Reference Standards (kWh/ kVArh Standard, CT Standards and VT Standards) are calibrated from TCA and NMI on the due dates.
- Secondary (Working) Reference Standards for error measurement.

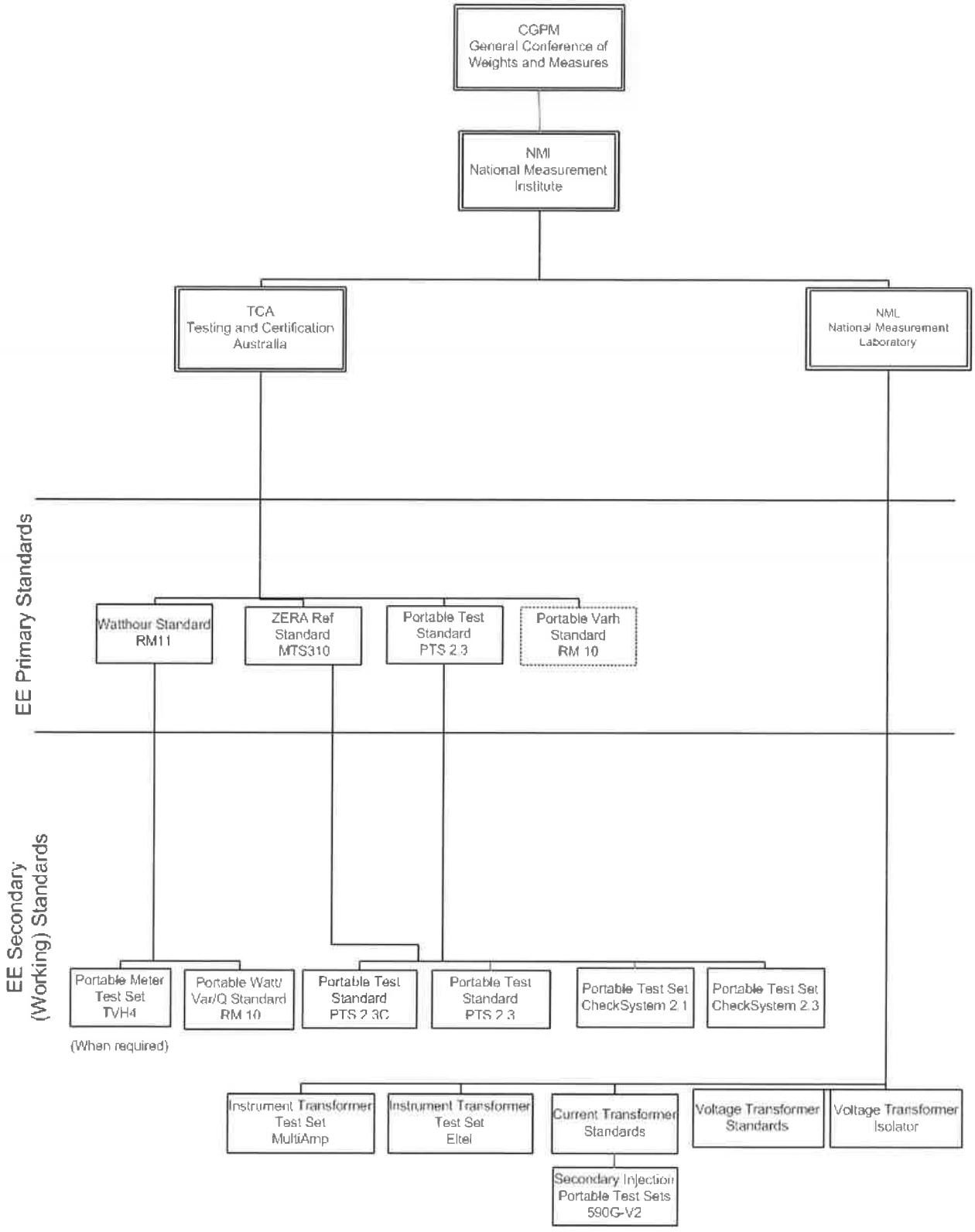
Annexure A gives the hierarchy of the EE/AMD Primary and Secondary (working) standards with traceability.

Calibration traceability records are maintained for all testing instruments and standards (LMT001). These records are kept in the custody of the Engineering Officer - Metering (Huntingwood Metering Laboratory), who performs the calibration of working standards viz RM10, PTS2.3/2.3C[5] at regular intervals (annually).

[5] RM10 Medtronic Portable Watt hours Standard
PTS 2.3/2.3C is a portable test system from MTE (Metering Test Equipment), and consists of an integrated three-phase 100A current source unit and a three-phase electronic reference standard available in Class 0.1 or 0.2.

Annexure A

EE / AMD Test Equipment Hierarchy and Traceability



Note: PTS testing equipment are issued to Meter Technicians for field use.

Quantities and the status of calibration of the above standards are as per LMT001: AMD Primary and Working Standards Device Register V1.00

Annexure B

Test Points and Error Limits for Testing of Meters & LV CTs

CT Connected Meter							WC Meter						
Test Point	Maximum % Error Limit						Test Point	Maximum % Error Limit					
	Unity pf		0.866 pf lag		0.5 pf lag	0.8 pf lead		Unity pf		0.866 pf lag		0.5 pf lag	0.8 pf lead
	Imp	Exp	Active	React.	Active	Active		Imp	Exp	Active	React.	Active	Active
Type 1 Interval Meters (Import/Export [6]) – Class 0.2S (AS62053.22)													
0.1 In	± 0.2						Not Applicable						
0.5 In	± 0.2		± 0.2	± 0.4	± 0.3	± 0.3							
1.0 In	± 0.2	± 0.2											
2.0 In	± 0.2												
Types 2, 3, 4 & 5 Interval Meters (Import/Export) - Class 0.5S (AS62053.22)													
0.1 In	± 0.5						Not Applicable						
0.5 In	± 0.5		± 0.6	± 1.2	± 0.6	± 0.6							
1.0 In	± 0.5	± 0.5											
2.0 In	± 0.5												
Types 4 & 5 Interval Meters (Import/Export) - Class 1.0 (AS62053.21)													
Not Applicable							0.1 Ib	± 1.0					
							1.0 Ib	± 1.0	± 1.0				
							0.5 Imax	± 1.0		± 1.0	± 2.0	± 1.0	± 1.0
Types 6 Accumulation Meters (Import) - Class General Purpose (AS1284.1)													
0.1 In	± 1.5						0.1 Ib	± 1.5					
0.5 In							1.0 Ib	± 1.5				± 1.5	
1.0 In	± 1.5				± 1.5		0.5 Imax	± 1.5					
2.0 In	± 1.5												
Types 6 Accumulation Meters (Import & Import/Export) - Class 1.0 (AS62053.21)													
Not Applicable							0.1 Ib	± 1.0					
							1.0 Ib	± 1.0	± 1.0			± 1.0	
							0.5 Imax	± 1.0					

Note: Class 0.2S/0.5S CT interval meters are normally tested at 9 Test points and WC interval meters at 8 test points

In-Service Compliance Testing to AS1284.13 and Customer Complaints Class General Purpose (AS1284.1)					
CT Connected Meter			WC Meter		
Test Point	Maximum % Error Limit		Test Point	Maximum % Error Limit	
	Unity pf	0.5 pf lag (Active)		Unity pf	0.5 pf lag (Active)
0.05 In	± 1.5		0.1 Ib	± 1.5	
In	± 1.5	± 1.5	1.0 Ib	± 1.5	± 1.5
2.0 In or Imax (whichever is the lesser)[7]	± 1.5		0.5 Imax (Optional)[7]	± 1.5	
In-Service Compliance Testing to AS1284.13 and Customer Complaints Class 1.0 (AS1284.5 and AS62053.21)					
0.05 In	± 1.0		0.1 Ib	± 1.0	
In	± 1.0	± 1.0	1.0 Ib	± 1.0	± 1.0
2.0 In or Imax (whichever is the lesser)[7]	± 1.0		0.5 Imax (Optional)[7]	± 1.0	
In-Service Compliance Testing to AS1284.13 and Customer Complaints Class 0.5S (AS62053.22)					
0.05 In	± 0.5		Not Applicable		
In	± 0.5	± 0.6			
2.0 In or Imax (whichever is the lesser)[7]	± 0.5				

In-Service Compliance Testing of LV CTs in-situ AEMO's Alternative Testing Minimum Requirements (AS 60044.1)						
Test Burden (at rated burden)	Power Factor	% Rated Current		Current Error Limits	Phase Displacement Limits (Minutes)	Phase Displacement Limits (crad)
		Multi tap CTs	Single & Extended CTs			
25% and 100%[8]	Unity	5	5	± 1.5	± 90	± 2.7
		20	20	± 0.75	± 45	± 1.35
		50[8]	100	± 0.5	± 30	± 0.9
		100	120[8]	± 0.5	± 30	± 0.9
		120[8]	Extended range x rated current	± 0.5	± 30	± 0.9

[6] *Import* is flow of electricity to the customer from the Network, and *Export* is from the customer to the Network.
[7] Depends on the meter current ratings.
[8] Additional test points and test burdens recorded for statistical purposes.

Annexure C

Meters' Population Groups for Sample Testing[9] (In-service Compliance Test)

Pop Description	Pop No.	Pop Size Basic	Pop Size Type 5	Total Population	Sample Size/ Tested	Compliance Period	Next Test or Projected Replacement	Last tested
BAZ 1p WC	1	47930		47930	150	7 years	17/18	2010/2011
HMT 1p WC	2	6917		6917	75	5 years	21/22	2016/2017
WF2 1p WC	3	11797		11797	100	7 years	17/18	2010/2011
SD 3p LVCT	4	107		107	10	5 years	17/18	2012/2013
SD 3p WC Over 6 Series	5	10995		10995	100	5 years	21/22	2016/2017
WF3 1p WC	6	85129		85129	150	7 years	20/21	2013/2014
M1 1p WC 1966-1975	7	13015		13015	100	7 years	17/18	2010/2011
SDM 3p WC 1966-1985	8	20636		20636	100	7 years	21/22	2014/2015
M2 1p WC	9	26946		26946	100	7 years	19/20	2012/2013
M2 3p WC	10	372		372	20	7 years	19/20	2012/2013
S203 3p WC	12	1570		1570	50	7 years	19/20	2012/2013
M1 1p WC 1976-1980	13	43892		43892	150	7 years	19/20	2011/2012
M1 1p WC 1981-1985	15	58517		58517	150	7 years	23/24	2016/2017
M3 1p WC	16	391149		391149	200	7 years	21/22	2014/2015
M1 1p WC 1986-2000	17	35630		35630	100	7 years	19/20	2012/2013
L262 3p WC	19	5261		5261	75	7 years	17/18	2010/2011
A1K 3p WC	20	93		93	10	7 years	17/18	2010/2011
SDM 3p WC 1991-1995	21	339		339	20	7 years	17/18	2010/2011
A11 1p WC	22	4473		4473	75	7 years	23/24	2016/2017
A1K 3p LVCT	23	145		145	10	4 years	20/21	2016/2017
SDM 3p LVCT	24	1148		1148	35	5 years	22/23	2016/2017
CM170 1p WC 1966-2000	25	162242		162242	200	7 years	21/22	2014/2015
EMS 1p WC (Nelson)	26	5884		5884	75	5 years	21/22	2016/2017
P1 1p WC	27	172		172	15	5 years	17/18	2011/2012
Q4 3p WC	28	419	96	515	25	10 years	21/22	2011/2012
Q4 3p LVCT	29	845	52	897	35	8 years	19/20	2011/2012
EDAWPA 3p WC (Atlas MK10)	30	281	248	529	20	10 years	21/22	2011/2012
E1114B 1p WC	31	3406		3406	75	10 years	21/22	2011/2012
E3314A 3p WC	32	603		603	35	10 years	21/22	2011/2012
E1210B 1p WC	33	857		857	35	10 years	23/24	2013/2014
E1210P 1p WC	34	956		956	35	10 years	23/24	2013/2014
A1000A 1p WC 2007-2011 (Actaris)	35	12613		12613	100	10 years	21/22	2011/2012
EM531A 3p LVCT	36	593	37	630	35	4 years	17/18	2013/2014
EDA7A-X 1p WC (Atlas MK7A)	37	52		52	7	10 years	23/24	2013/2014
E1000A 1p WC	38	2161	18	2179	50	10 years	20/21	2010/2011
E1212B 1p WC	39	237		237	15	10 years	22/23	2012/2013
E1212A 1p WC	40	656		656	35	10 years	23/24	2013/2014
EM333B 3p WC	41	558		558	35	10 years	21/22	2011/2012
EM303A 3p WC	42	21611		21611	100	10 years	23/24	2013/2014
EM333A 3p WC	43	8		8	3	10 years	23/24	2013/2014
MN100A 1p WC (Metronet 1 Element)	44	632		632	35	10 years	23/24	2013/2014

Continued:

Pop Description	Pop No.	Pop Size Basic	Pop Size Type 5	Total Population	Sample Size/ Tested	Compliance Period	Next Test or Projected Replacement	Last tested
MN310A 3p WC (Metronet)	46	122		122	10	10 years	23/24	2013/2014
K410 3p WC (Enermet)	47	3152		3152	75	5 years	21/22	2016/2017
Q3 3p LVCT	48	218	17	235	15	4 years	20/21	2016/2017
Q3 3p WC	49	233	63	296	15	5 years	17/18	2012/2013
ZE3NLA 3p WC (Elster A1800 Mesh)	50	121		121	10	10 years	23/24	2013/2014
EDAAWA 3p WC (Atlas MK10A)	51	1130	11	1141	35	10 years	23/24	2013/2014
EM500 1p WC	52	52405		52405	150	10 years	25/26	2015/2016
EDA1D-X 3p WC (Atlas MK10D)	53	129		129	15	10 years	23/24	2013/2014
EDA7C-X 1p WC (Atlas MK7C)	54	1961	34	1995	50	10 years	25/26	2015/2016
CM170 1p WC 2001-2010	55	270107		270107	200	7 years	19/20	2012/2013
EDAE5A 3p LVCT (Atlas MK10E)	56	72	12	84	15	8 years	21/22	2013/2014
EDN5RA 3p LVCT (Genius MK6)	58	165	19	184	10	4 years	17/18	2013/2014
EDG5R-X 3p LVCT (Genius)	59	105	41	146	35	8 years	19/20	2011/2012
U1211A 1p WC (L&G Mesh 1 element)	60	547		547	35	10 years	24/25	2014/2015
U3301A 3p WC (L&G Mesh)	61	723		723	35	10 years	24/25	2014/2015
U1225A 1p WC (L&G Mesh 2 elen	62	490		490	15	10 years	24/25	2014/2015
ICM51A 1p WC (PRI Mesh 1 elem	63	209		209	15	10 years	24/25	2014/2015
ICM52A 1p WC (PRI Mesh 2 elem	64	229		229	7	10 years	24/25	2014/2015
ZGA7DA 1p WC (Elster gRex Mesh	65	75		75	35	10 years	24/25	2014/2015
LB3ABA 3p WC (Elster A1100)	67	27787		27787	100	10 years	25/26	2015/2016
LB3ADA 3p WC (Elster A1100)	68	15998		15998	100	10 years	25/26	2015/2016
EM513A 3p WC	70	143	10	153	10	10 years	25/26	2015/2016
EM513B 3p WC	71	1483		1483	50	10 years	25/26	2015/2016
A100A 1p WC 2012-2016 (Actaris)	72	128995		128995	150	10 years	25/26	2015/2016
SPD100 3p WC (PRI Sprint)	73	119		119	10	10 years	25/26	2015/2016
Sub Total (ISC)		**1487565**	**658**	**1488223**	**3942**			
Meter Replacment Plan								
SD 2p WC	201	2184		2184	50			
SDM 2p WC	202	1437		1437	50			
SDM 3p WC 1986-1990	206	2642		2642	50			
SD 3p WC Under 6 Series	207	5915		5915	75			
M1 1p WC 1961-1965	208	168		168	15			
SDM 3p WC 1996-2000	209	1372		1372	50			
C3-XXXX 3p WC (Calmu)	210	167		167	15			
ZMD11E 3p WC	213	24094		24094	100			
SDM 1p WC 1996-2000	214	192		192	15		Note b	
Unidentified Meters	215	4747		4747	100		Note a	
Bulk Change		**42918**		**42918**				
Total Pop Size (Type 6)		**1530483**		**1531141**	**3942**			

NOTE a): The unidentified meters exist in CSS are due to amalgamation of Illawarra electricity and Prospect electricity. Endeavour Energy has identified/replaced 75,505 meters and currently continuing to identify the balance of 4,747 meters. This group was originally at 80,287 meters.

NOTE b): Included in the Bulk replacement program due to failure of sample testing as per section 11 and Annexure E.

NOTE: The data is current as of June 2017.

NOTE: Meters with a compliance period of 10 years are less than 10 years old and have not yet been tested in the field.

[9] The total population of meters in Type 5 and Type 6 reviewed and meters grouped in to representative populations consist of meters of the same pattern or type (metrological specifications) and to have been manufactured under the same conditions (AS/NZS 1284.13:2002).

Annexure D

EE Network LV CTs' Population Groups for Sample Testing

Group No	Model Type Description	CT population 2017-18	10% of population 2017-18	Sum of variance 2012 to 17*	Difference variance to tests 2016-17	Revised planned tests 2017-18
1	Type A 150/300/600/5 CT	160	16	46	30	**0**
2	Type B 200/400/800/5 CT	143	14	42	28	**0**
3	Type B 400/800/1200/5 CT	45	5	11	6	**0**
4	Type C 1000/2000/3000/5 CT	2	0	2	1	**0**
5	Type S 200/5 CT	3420	342	-122	-464	**464**
6	Type T 800/5 CT	292	29	-31	-60	**60**
7	Type W 1500/5A CT (Note 1)	4	0	0	0	**0**
	Grand Total	**4066**	**407**			**524**

*Refer to Section 3

Note 1: Type W 1500/5A are new CTs and not yet due for testing.
Note: The above Pop Size (Premises) for the respective Model Type CTs is approximate numbers. Testing of the population is in accordance with section 12.2

Progress in June 2017 for CT testing 2016/2017, total tests completed was 247 out of 410, which is 60%. The target could not be achieved due to issues associated with organizing outages, change in branch structure. An Engineering Officer whose primary function is CT testing and management of the CT testing program started in June 2016

Annexure E

Summary of MAMP implementation

The proposed volume of work (sites) is summarised below.

Network	MI Type	Plan	17-18	18-19	19-20	20-21	21-22
Meter Test & Inspection Plans		**Carry over from 2016/2017**	**96**				
EE Network	Type 5 & 6	Sample Test/ Site Inspection	540	340	350	225	1240
Total Sites (Meter Testing & Inspection)			**636**	**340**	**350**	**225**	**1240**
LV CT Testing	Type 5 & 6	**Carry over from 2012 to 2017**	**117**				
EE Network **(NOTE 1)**			407	387	367	349	332
Total Sites (LV CT Testing)			**524**	**387**	**367**	**349**	**332**
Total Yearly Sites to Visit for Tests & Inspections			**1160**	**727**	**717**	**574**	**1572**
Asset Replacement Plan							
EE Network **(NOTE 2)**	Type 6	Bulk Meter Change Sect 12	1000	41918			
Total (Asset Replacement)			**1000**				
Total Yearly Sites to Visit			**2160**	**727**	**717**	**574**	**1572**

Note: Metering assets on EE Network excludes meters installed in transmission and zone substations, as these are non-market assets and used for statistical metering.

EE utilise own resources and test capability for all Plans in EE Network while Bulk Meter Change has been outsourced.

Power of Choice commences on 1 December 2017. From this date, it is anticipated that Endeavour Energy will provide Retailers/Meter Providers with a list of meter types that do not meet the metrology requirements and the Retailer/Meter Provider should replace these with smart meters as a priority.

Number of In-service Compliance tests due in 2019/20 is 690. This has been split across 2018/19 and 2019/20 as best fit with meter types to assist resource levelling.

Annexure F

References

AER Compliance Bulletin No.6 – December 2011

Alternative Testing Minimum Requirements – Low Voltage Current Transformer Metering Installations

AS/NZS 1284.13: *Electricity metering: In-service compliance testing*

AS62052.11- 2005: *Electricity Metering Equipment (AC) – General Requirements, tests and test conditions*

AS62053.11-2005: *Electricity Metering Equipment (AC) – Particular Requirements, Part 11: Electromechanical Meters for active energy (Classes 0.5, 1 and 2)*

AS62053.21-2005: *Electricity Metering Equipment (AC) – Particular Requirements, Part 21: Static meters for active energy (Classes 1 and 2)*

AS62053.22-2005: *Electricity Metering Equipment (AC) – Particular Requirements, Part 22: Static meters for active energy (Classes 0.2S and 0.5S)*

AS1675-1986: *Current Transformers – Measurement and Protection*

AS1243-1982: *Voltage Transformer for Measurement and Protection*

AS60044.1-2007: *Instrument Transformers Part 1: Current Transformer*

AS60044.2-2007: *Instrument Transformers Part 2: Inductive Voltage Transformer*

AS60044.3-2004: *Instrument Transformers Part 3: Combined Transformers*

AS60044.5-2004: *Instrument Transformers Part 5: Capacitor Voltage Transformer*

EE Corporate Policy No 9.6.6 - *Metering Assets*

IEC62058-31-2007: Acceptance Inspection for static meters for active energy

Metrology Practice No. 4 - *Meter Replacement and Refurbishment Policy*

National Electricity Rules, *Chapter 7 – Metering*

National Electricity Market - Metrology Procedure; Part A and Part B

NMT 8009 - *Meter Asset Management Strategy*

NMT 3010 - Metering Assets Administration Manual

NMT 3011 - Metering Assets Maintenance Manual

NSW Market Operation Rules (Part 3) – *MOR3*

Service and Installation Rules of NSW

WMT 3528 Meter In-Service compliance and dispute accuracy testing

WMT 1564 - Low Voltage CT Metering Installations In-service Test

WMT1565 - HV Metering In-service Test

1.1.1 Sub delegations of authority by the Chief Executive Officer

Annexure G

Abbreviations and Definitions

AEMO	Australian Energy Market Operator
AS	Australian Standard
Capex	Capital Expenditure
CEO	Chief Executive Officer
CSS	Customer Service System (Banner)
CT	Current Transformer
GM	General Manager
GWh	Giga (10^9) Watt-hours
HV	High Voltage (≥1000V)
EE	Endeavour Energy
KWh	Kilo (10^3) Watt-hour
KVArh	Kilo Volt Ampere Reactive hour
LNSP	Local Network Service Provider
LV	Low Voltage (<1000V)
MAMP	Metering Asset Management Plan
MDP	Meter Data Provider
AMD	Asset & Metering Data
MI	Metering Installation
MP	Meter Provider
MWh	Mega (10^6) Watt-hours
NATA	National Association of Testing Authority
NER	National Electricity Rules
NITP	National Instrument Test Procedure for Utility Meters
NMI	National Measurement Institute
NML	National Measurement Laboratory
Opex	Operating Expenditure
PI	Primary Injection
Pop	Population
RP	Responsible Person
SVI	Secondary Voltage Injection
TCA	Testing and Certification Authority
TOU	Time of use
VT	Voltage Transformer
WC	Whole Current

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