| Eskom | Standard | Technology |
|---|---|---|

Title: **ACCELERATED ENVIRONMENTAL STRESS TESTING FOR SOLID-STATE ELECTRICITY METERING EQUIPMENT**

| | |
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## Content

**Figures**



**Tables**

# 1. Introduction

The Accelerated Environmental Stress Test (AEST) is a fast laboratory method that stimulates the occurrence of failure modes metering equipment would experience throughout its *useful life* in its intended operating environment. This holds considerable advantage as it is then possible to rectify potential problems before large-scale installation takes place. It can therefore be utilised as a technical evaluation tool for metering equipment submitted in response to national tender enquiries.

During AEST, a batch of identical meters (same model and version) is subjected to three temperature/humidity cycles per day for a set number of test days, and each meter immediately replaced with a new one upon failure, until the *cumulative test time* reached a predefined target, typically 10 years. Additional stress parameters are synchronised with the temperature/humidity cycles so that each of these parameter cycles, as experienced by each individual meter, may also be concatenated.

The procedure draws upon various South African National Standards (SANS) and International Electrotechnical Commission (IEC) documents for values and frequency of application of the stress parameters. However, it is not the intention to perform type tests; rather an attempt is made to represent prevailing yet harsh field conditions whilst remaining within the broad confines of the recognised specifications. It focuses on the risk that particular failures/events pose to Eskom in terms of expected field performance due to environmental stresses.

# 2. Supporting clauses

## 2.1 Scope

### 2.1.1 Purpose

The purpose of this document is to set a standard procedure for *Accelerated Environmental Stress Testing* of all types of electricity metering equipment within the scope of the *SCOT Metering & Measurements Study Committee* including AMI devices (i.e. smart meters, data concentrators, appliance control devices and customer interface units). This will enable the demonstration of the equipment's functional reliability in terms of hardware and software through the detection of failure modes relating to *design errors, component quality problems* and *manufacturing process problems*.

### 2.1.2 Applicability

This document is applicable to Eskom Holdings Limited.

## 2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

### 2.2.1 Normative

[1] SANS 1524-1:2010, Ed 5, Electricity payment systems Part 1: Prepayment meters

[2] NRS 049:2008, Ed 1, Advanced metering infrastructure (AMI) for residential and commercial customers

[3] SANS / IEC 62052-11:2003, Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 11: Metering equipment

[4] SANS / IEC 62053-21:2003, Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)

[5] SANS / IEC 62053-22:2003, Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0.2 S and 0.5 S)

[6] SANS / IEC 62053-23:2003, Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)

[7] SANS / IEC 62053-23:2003, Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)

[8] DSP 34-1635, Particular requirements for prepayment meters

[9] DSP 34-866, Specification for three phase active energy meters: whole current

[10] DSP 34-869, Specification for three phase programmable energy meters

[11] DST 34-391, Standard for display sequences on electronic meters

[12] IEC 61000-4-2:2001, Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

[13] IEC 61000-4-4:2004, Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrostatic fast transient/burst immunity test

[14] IEC 61000-4-5:2001, Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

[15] IEC/TR 62059-21:2002, Electricity metering equipment – Dependability – Part 21: Collection of meter dependability data from the field

### 2.2.2 Informative

[16] Koert, AJ, *Accelerated Environmental Stress Test for Pre-payment Metering*, Ver. 4.00, Eskom Research Report: RES/RR/00/11740, Apr 2000.

[17] Koert, AJ, Accelerated Environmental Stress Test for 3-Phase Domestic & Industrial Meters, Version 1, Eskom Research Report: RES/RR/04/24524, Jun 2005.

[18] Groenewald, HPD, Procedure for Accelerated Environmental Stress Testing on Advanced Metering Infrastructure Equipment, Eskom Distribution Procedure: 34-1943, March 2009.

## 2.3 Definitions

### 2.3.1 General

| Definition | Description |
|---|---|
| **Accelerated life test** | A test in which the applied stress level is chosen to exceed that stated in the reference conditions in order to shorten the time duration required to observe the stress response of the item, or to magnify the response in a given time duration<br>**NOTE:** To be valid, an accelerated life test shall not alter the basic fault modes and failure mechanisms, or their relative prevalence.<br>[IEV 191-14-07 modified] |
| **Basic current, Ib** | Value of rms current in accordance with which the relevant performance of a direct-connected meter are fixed<br>**NOTE:** Standard values are 5, 10, 15, 20, 30, 40, 50 A<br>[IEC 62052-11] |
| **Class index** | Number which gives the limits of the permissible percentage error, for all values of current between $0.1I_b$ and $I_{max}$, or between $0.05I_n$ and $I_{max}$, for unity power factor (and in the case of polyphase meters with balanced loads) when the meter is tested under reference conditions [IEC 62052-11] |
| **Common mode coupling** | Line-to-earth coupling of transient or surge; this may apply to all lines simultaneously |

| Definition | Description |
|---|---|
| **Constant failure rate period** | That period, if any, in the life of a non-repaired item during which the failure rate is approximately constant [IEV 191-10-09] |
| **Current readings** | Meter readings of the current season or current billing month |
| **Differential mode coupling** | Line-to-line coupling of transient or surge |
| **Failure** | Termination of the ability of an item to perform a required function [IEV 191-04-01, modified] |
| **Failure cause** | The circumstances during design, manufacture or use which have led to a failure<br>**NOTE:** The term “root cause of failure” is used and described in IEC 62059-21<br>[IEV 191-04-17] |
| **Failure mechanism** | The physical, chemical or other process which has led to a failure [IEV 191-04-18] |
| **Fault** | The state of an item characterised by the inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources<br>**NOTE:** A fault is often the result of a failure of the item itself, but may exist without prior failure.<br>[IEV 191-05-01] |
| **Fault mode** | One of the possible states of a faulty item, for a given required function<br>**NOTE 1:** The use of the term “failure mode” in this sense is now deprecated.<br>**NOTE 2**: A functional-based fault mode classification is described in IEC 62059-21.<br>[IEV 191-05-22, modified] |
| **Historical readings (stack)** | Snapshot meter readings of the previous seasons or previous billing months |
| **Maximum current, Imax** | Highest value of rms current at which the meter purports to meet the accuracy requirements of the relevant standard<br>**NOTE 1:** Direct-connected meters: preferably an integral multiple of Ib, e.g., 4Ib<br>**NOTE 2:** Transformer-operated meters: typically 1.2In but may also be 1.5In or 2In (refer to meter model documentation)<br>[IEC 62052-11] |
| **Mean time to failure** | The expectation of the time to failure<br>**NOTE:** The term “expectation” has statistical meaning.<br>[IEV 191-12-07 modified] |
| **Non-relevant failure** | A failure that should be excluded in interpreting test or operational results or in calculating the value of a reliability performance measure<br>**NOTE:** The criteria for the exclusion should be stated.<br>[IEV 191-04-14] |
| **Rated current, In** | Value of rms current in accordance with which the relevant performance of a transformer-operated meter is fixed<br>**NOTE:** Standard values are 1, 2, 5 A<br>[IEC 62052-11] |

| Definition | Description |
|---|---|
| **Reference voltage, Un** | Value of the rms voltage in accordance with which the relevant performance of the meter is fixed<br>**NOTE 1:** Direct-connected meters: standard values are 120, 230, 277, 400, 480 V<br>**NOTE 2:** Transformer-operated meters: standard values are 57.7, 63.5, 100, 110, 115, 120, 200 V<br>[IEC 62052-11] |
| **Relevant failure** | A failure that should be included in interpreting test or operational results or in calculating the value of a reliability performance measure<br>**NOTE:** The criteria for the inclusion should be stated.<br>[IEV 191-04-13] |
| **Reliability test** | Experiment carried out in order to measure, quantify or classify a reliability measure or property of an item<br>**NOTE 1:** Reliability testing is different from environmental testing where the aim is to prove that the items under test can survive extreme conditions of storage, transportation and use.<br>**NOTE 2:** Reliability test may include environmental testing. |
| **Stress condition** | Set of conditions to which the metering equipment is exposed during accelerated reliability testing |
| **Surge** | A transient wave of electrical current, voltage, or power propagating along a line or a circuit and characterised by a rapid increase followed a slower decrease<br>[IEV 161-08-11 modified] |
| **Time to failure** | Cumulative operating time of an item, from the instant it is first put in an up state, until failure or, from the instant of restoration until next failure [IEV 191-10-02 modified] |
| **Time to suspension** | Cumulative operating time of a non-failed item, from the instant it is first put in an up state or from the instant of restoration, until the test is terminated (censored) |
| **Time-of-use metering** | Metering installations where the recorded energy or demand is derived over certain time periods of a day |
| **Total kWh reading** | kWh accumulated over all time periods for a multi-rate meter, i.e., the sum of kWh readings in all time-based registers |
| **Transient** | Pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval which is short compared with the time-scale of interest<br>**NOTE 1**: Fast Transient Burst (FTB) applications (IEC 61000-4-4) simulate switching transients due to interruption of inductive loads, relay contact bounce, etc. (IEC 61000-4-4)<br>**NOTE 2:** Lightning impulse (surge) applications simulate lightning transients<br>(IEC 61000-4-5).<br>[IEV 161-02-01] |

### 2.3.2 Disclosure classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 Abbreviations

| Abbreviation | Description |
|---|---|
| **AEST** | Accelerated Environmental Stress Test |
| **AMI** | Advanced Metering Infrastructure |
| **CIU** | Customer Interface Unit |
| **CoE** | Centre of Excellence |
| **DUT** | Device-under-test |
| **ECU** | Electricity Control Unit (pre-payment meter with earth leakage protection) |
| **ED** | Electricity Dispenser |
| **ESD** | Electrostatic Discharge |
| **FTB** | Fast Transient Burst |
| **Hz** | Hertz |
| **kWh** | Kilo Watt-hour |
| **LAP** | List of Approved Products |
| **LCD** | Liquid crystal display |
| **LED** | Light emitting diode |
| **LI** | Lightning impulse |
| **MD** | Maximum Demand |
| **MTBF** | Mean time between failures |
| **MTTF** | Mean time to failure |
| **PTM&C** | Protection, Telecommunication, Metering and Control |
| **RH** | Relative humidity |
| **rms** | Root mean square |
| **RT&D** | Research Testing and Development |
| **SATS** | South African Standard Time |
| **STS** | Standard Transfer Specification |
| **TOU** | Time-of-use |
| **TT** | Token transfer |

## 2.5 Roles and responsibilities

The R,T&D (Group Sustainability) and PTM&C (Group Technology) shall use this document as the basis for conducting Accelerated Environmental Stress Testing on all electricity metering equipment within the scope of the *SCOT Metering & Measurements Study Committee*.

## 2.6 Process for monitoring

The Metering and Measurement Study Committee shall ensure that this standard is implemented.

## 2.7 Related/supporting documents

This document supersedes DPC 34-1943: Procedure for Accelerated Environmental Stress Testing on Advanced Metering Infrastructure Equipment.

# 3. General

An AEST may be performed with one of three main objectives in mind:

- As a technical evaluation tool for evaluation of metering equipment submitted for national tenders with the result of inclusion on Eskom's List of Approved Products (LAP), i.e., **"Enquiry"**
- To confirm inclusion on Eskom's LAP following production line stabilisation, or to investigate approved metering product due to unsatisfactory field performance, or to re-evaluate approved metering product usually triggered when the manufacturer submits a Request for Modification (RFM), i.e., **"Routine"**
- To aid in product development, as requested by a manufacturer, i.e., **"Developmental"**

The different approaches necessary to meet each objective are given in sections 3.1 to 3.3 herein.

## 3.1 Enquiry

For "Enquiry" purposes the following apply:

a) In the interest of confidentiality, neither participating nor non-participating manufacturers will be allowed into the Testing laboratory.

b) In the event of a meter or sub-unit failure, the event will be recorded and the entire DUT replaced with a spare. Similarly, in the event of a concentrator or sub-unit failure, the entire DUT will be replaced with a spare. Manufacturers will not have access to failed metering equipment; at the close of the test, all tested metering equipment will remain the property of Eskom.

c) Should a particular metering equipment variant cause excessive delay to the test (e.g. continual tripping), the Test Operator will call a meeting with:

   1) PTM&C (Eskom)

   2) other relevant Eskom parties

   with a view to removing the metering equipment variant from the test.

d) For the duration of the test, the Test Operator will issue weekly status reports to PTM&C.

e) At the close of the test, the Test Operator will issue final reports to PTM&C covering each manufacturer's metering equipment variants.

## 3.2 Routine

For "Routine" purposes the following apply:

a) In the interest of confidentiality, neither participating nor non-participating manufacturers will be allowed into the Testing laboratory, unless the manufacturer is a sole participant.

b) In the event of a meter or sub-unit failure, the event will be recorded and the entire DUT replaced with a spare. Similarly, in the event of a concentrator or sub-unit failure, the entire DUT will be replaced with a spare. The relevant manufacturer is to collect the failed metering equipment and, within one week, investigate the cause of failure, submit a comprehensive failure report and return the repaired metering equipment to the Test Operator.

c) Should a particular metering equipment variant cause excessive delay to the test, e.g., continual tripping, the Test Operator will call a meeting with:

1) PTM&C (Eskom)

2) other relevant Eskom parties

3) relevant manufacturer

to resolve the issue that may include suspending the test for the particular metering equipment variant.

d) For the duration of the test, the Test Operator will issue weekly status reports to PTM&C and the relevant manufacturer.

e) At the close of the test, the Test Operator will issue final reports covering each manufacturer's metering equipment variants to PTM&C and the relevant manufacturer.

f) Research, Testing & Development (Eskom) reserves the right to retain 2 DUTs (tested or spare) per tested variant, as test specimens. The relevant manufacturer is to collect all other DUTs (tested and spare).

## 3.3 Developmental

For “Developmental” purposes the following apply:

a) In the interest of confidentiality, neither participating nor non-participating manufacturers will be allowed into the Testing laboratory, unless the manufacturer is a sole participant.

b) In the event of a meter or sub-unit failure, the event will be recorded and the entire DUT replaced with a spare. Similarly, in the event of a concentrator or sub-unit failure, the entire DUT will be replaced with a spare.

c) Should a particular metering equipment variant cause excessive delay to the test (e.g. continual tripping), the Test Operator will call a meeting with the relevant manufacturer to resolve the issue that may include suspending the test for the particular metering equipment variant.

d) For the duration of the test, the Test Operator will issue weekly status reports to the relevant manufacturer.

e) At the close of the test, the Test Operator will issue a final report to the relevant manufacturer. The relevant manufacturer is to collect all DUTs (tested and spare).

# 4. Test batch requirements

If the objective of the test is “developmental”, then the manufacturer can select the required number of DUTs and send/deliver these to the Eskom R,T&D Testing Laboratory . For “enquiry” and “routine” purposes, the Test Operator shall perform random sampling on the manufacturer's production line(s) to obtain the requisite test sample.

Sampling may be performed over a number of days to ensure that the obtained sample is no larger than 5% per manufactured batch using random sampling techniques. It is preferable that sampling is performed when the production lines are stable and operating at normal capacity.

Using a random number generator, e.g., calculator or computer, or random number tables, several approaches may be used for each of concentrator (and sub-unit where applicable) and meter (and sub-unit(s) where applicable), such as:

- Generating random number sequences of *N* serial numbers for units and sub-units – the disadvantage is that this requires the serial number ranges to be known upfront for the sampling period
- Generating a random number sequences of *N* ordinal numbers from within the expected through-put of the production line for units and sub-units over the sampling period, e.g., 5$^{th}$, 39$^{th}$, 100$^{th}$, 106$^{th}$, 126$^{th}$, 199$^{th}$, …, 1003$^{rd}$ and picking these from the line(s) as they are manufactured

- Generating random sequences of *N* time-stamps at which the units and sub-units are to be picked from the production line(s), as they are manufactured over the sampling period – this approach is recommended.

For common-coding purposes – refer to section 4.2.1 – it may be necessary to pick the meters from the production line(s) before they are sealed.

Where random sampling was not possible, this shall be clearly stated in the final test report. Typically this could occur when a new product is to be tested where the sample comprises hand-made units and sub-units. This must be considered as a factor in the "enquiry".

## 4.1 Determination of sample size

Sample size per metering equipment variant depends on a number of factors:

- Required **simulated time** for the metering equipment variant
- Available space in environmental chamber that in turn depends on the number and types of metering equipment variants to be tested
- Cost of metering equipment, i.e., larger sample sizes can be accommodated for *en masse* installations, e.g., pre-payment meters
- Whether a Drop Test is required (refer to section 5.2)
- Number of **spare** DUTs required to replace failed DUTs
- **Extra DUTs** required for testing, e.g., by PTM&C or for exploratory testing

### 4.1.1 Simulated time

The required simulated time for a metering equipment variant is usually 10 years and is determined by the following equation:

$$Simulated\ time\ for\ variant\ (years) = Total\ exposure\ time\ of\ all\ DUTs\ on\ test = \frac{f \cdot n \cdot t_d}{365}$$

where

*f* is the number of temperature/humidity cycles per day, i.e., 3 $day^{-1}$

*n* is the number of DUTs in the environmental chamber

$t_d$ is the test duration in days

The limitations on *n* and $t_d$ are as follows:

AEST without the Drop Test: $n \geq 1$

AEST with the Drop Test: $n \geq 3$ and always a multiple of 3

$t_d \geq 21$ days (refer to section 5.4.2)

Furthermore, where an AMI system utilises concentrators, the sample size of the concentrator (with communication device, if applicable) shall be between 20% and 100% of the AMI meter sample size, i.e., no more than 5 meters per concentrator. Unless the concentrator sample size is equal to the meter sample size, the simulated time for the concentrator will inevitably be significantly shorter than that required of the meter unless the AEST is extended to attempt to compensate for this. The Test Operator shall liaise with PTM&C to determine suitable test length vs. concentrator sample size.

### 4.1.2 Spares and extra test units

The number of spare DUTs required will depend on the performance of the metering equipment variant in the AEST. The following is recommended:

- AEST without the Drop Test: 0.25*n* rounded up to the nearest whole number
- AEST with the Drop Test: 0.25*n* rounded up to the nearest multiple of 3

The Test Operator will determine whether any extra DUTs are required.

## 4.2 Sample configuration

After the DUTs have been sampled from the production line, they shall be configured on the manufacturer's premises.

### 4.2.1 Prepayment meters

Pre-payment meters are typically uniquely and securely coded during manufacture, as per STS rules and algorithms. Common-coding facilitates efficient entering of credit and other tokens during the AEST. Therefore the values as per Table 1 shall be loaded into all test meters in the presence of the Test Operator. Note that the test key is generated from a different master key to that of Eskom's Master Key and a **secure** module with the test details is required to code the meters using standard procedures. Alternatively the meter key can be written directly to the relevant location in the meter. The Test Operator should refer to relevant staff in prepayment in PTM&C for further information/advice.

**Table 1: Meter test key detail**

| METER PARAMETER | VALUE |
|---|---|
| Meter Key | 6caf f4b5 4a37 76a6 |
| Key Type | Unique |
| Tariff Index (TI) | 01 |
| Key Revision no. | 1 |
| Supply Group Code (SGC) | 333 333 |
| Meter no. | 0406 000 000 9 |
| Key Change Flags | 8 |
| Current Limit | 20 A or 60 A (for single phase meters)<br>80 A (for polyphase meters) |

### 4.2.2 Credit meters

The configuration of credit meters differ according to type of meter utilised. The Test Operator shall liaise with Eskom staff to determine if there are any further configuration parameters required than those listed in the following paragraphs.

Single rate meters

The meters shall be configured to indicate kWh only. The kWh energy readings shall be displayed to six digits plus one digit after the decimal point.

#### 4.2.2.1.1 TOU meters - direct (whole) current meters

The meters shall be configured with a TOU schedule that alternates between peak and off-peak every half-hour starting from off-peak at midnight. The time and date shall be set to South Africa Standard Time (SAST).

The meters shall be configured to record kWh as a minimum in its load-profile memory.

The meter display shall be configured to display date, time, off-peak kWh and peak kWh. The kWh energy readings shall be displayed to six digits plus one digit after the decimal point.

#### 4.2.2.1.2 TOU meters – transformer-operated

The meters shall be configured with a TOU schedule that alternates between peak and off-peak every half-hour starting from off-peak at midnight. The time and date shall be set to South Africa Standard Time (SAST).

The transformer ratios shall be set to 1 for both of the Voltage instrument transformer (where applicable) and Current instrument transformer ratios.

The meters shall be configured to record kWh as a minimum in its load-profile memory.

The meter display shall be configured to display date, time, off-peak kWh and peak kWh. The kWh energy readings shall be displayed to four digits plus three digits after the decimal point.

### 4.2.3 AMI equipment

Each meter shall be configured with a TOU schedule that alternates between off-peak and peak every half-hour starting from off-peak at midnight and shall be configured to switch the appliance control device on during off-peak periods and off during peak periods.

Each meter shall be configured to record kWh as a minimum in the load-profile memory. All events specified in NRS 049 shall also be recorded.

Each meter shall be configured to display date, time, off-peak kWh and peak kWh. The energy readings shall be displayed to six digits plus one digit after the decimal point.

Each CIU shall be configured to display off-peak kWh, peak kWh, appliance device status (open or closed) and the supply capacity control setting.

The Test Operator shall liaise with PTM&C to determine any further configuration parameters.

## 4.3 Sample information to be provided by manufacturer

The DUT manufacturer shall provide the Test Operator with the following for all meter variants (and their sub-units) and all concentrator variants (and their sub-units):

- Hardware version
- Software (firmware) version
- Any pertinent information relating to deviations in the sampled (or submitted) test batch from metering equipment batches to be included on Eskom's LAP.

## 4.4 Sample labelling

Upon receipt of a test batch, the Test Operator will uniquely and indelibly (permanent marker) label each item using a numbering scheme that allows full traceability of all meters and sub-units irrespective of the type of test to be conducted, e.g., AEST, ALT, *ad hoc*, exploratory testing, etc. The Test Operator shall label each meter and sub-unit (including spare and extra) using the following convention:

<yyzz-MMMv-D...D-nn>

where

*yy* Year, e.g., 13

*zz* Test number (01 to 99), i.e., all metering equipment subjected to a particular test, e.g., AEST, will be designated the same test number; this approach makes allowance for other non-AEST testing, e.g., *ad hoc*, exploratory testing

*MMM* First three letters of manufacturer, e.g., Conlog (CON), Itron (ITR), Landis+Gyr (LAN)

*v* Variant, i.e., a manufacturer may have more than one variant in a particular test, e.g., 1, 2, 3, etc.

*D...D* 3 or 4 letter abbreviation or acronym describing the unit or sub-unit, i.e., meter (MET), customer interface unit (CIU), meter communication device (MCOM), appliance control device (ACD), concentrator (CON), concentrator communication device (CCOM)

*nn* Unit number in batch, e.g., 01, 02, 03, etc.

**Examples:**

The first meter of the first variant sampled at ABCMeterMaker for the second test performed in 2013, would be labelled: 1302-ABC1-MET-01. Assuming that this is a split meter, its associated customer interface unit (sub-unit) would be labelled: 1302-ABC1-CIU-01.

For ABCMeterMaker's second variant in the same test and assuming AMI metering equipment, the first meter DUT and first concentrator DUT would be labelled as follows:

- 1st meter DUT:
  - 1302-ABC2-MET-01 (unit)
  - 1302-ABC2-CIU-01 (sub-unit)
  - 1302-ABC2-MCOM-01 (sub-unit)
  - 1302-ABC2-ACD-01 (sub-unit)
- 1st concentrator DUT:
  - 1302-ABC2-CON-01 (unit)
  - 1302-ABC2-CCOM-01 (sub-unit)

Referring to section 7, note that the test sheets used by the Test Operator throughout the test apply at DUT level. Therefore the test sheets need only list <*MMMv-D...D-xx*> at the unit level to describe each DUT, as shown in the example test sheets (section 7).

# 5. Test procedure

## 5.1 Pre-qualifying test

The purpose of this test is to verify that the entire test sample of *N* metering equipment units and sub-units is functional and that the registration accuracy is within applicable class limits, e.g., ± 2% for a class 2 meter, before any stress tests are applied.

a) Check for any broken/loose parts external to the metering equipment units and sub-units, e.g., face plate peeling off, broken circuit breaker toggle, damaged keys, broken scroll button

b) Check whether metering equipment units and sub-units rattle (broken/loose parts inside)

c) Check whether metering equipment powers up

**Note:** Any abnormal status indication (LED and/or LCD) contrary to operating instructions/manual of metering equipment

d) Check functionality of keys or scroll buttons

e) As applicable, check token entry (for magnetic card reader meters, note ease of token acceptance)

f) As applicable, check whether relevant metering equipment kWh registers increment

g) As applicable, check whether metering equipment credits decrement

h) As applicable, check whether metering equipment trips on zero credits

i) Take two kWh accuracy readings at $U_n$ and $I_b$ (or $I_n$ as applicable)

j) As applicable, check earth leakage operation

**Note:** Any deviations in performance compared to the rest of the test batch

The Test Operator shall record the data for the $n + n_s$ metering equipment units and sub-units according to section 7 and shall put aside or dispatch the $n_e$ metering equipment units and sub-units to PTM&C.

## 5.2 Vibration/Drop test

This test is performed at Gerotek or similar test facility having a vibration test table and drop test equipment.

### 5.2.1 Random vibration

Simulates road, rail and air transport.

- The $n + n_s$ portion of the test sample, including spare but excluding extras, in bulk packaging and, where unavoidable, in individual packaging
- 0.02$g^2$/Hz between 20 Hz and 50 Hz falling to 0.001$g^2$/Hz @ 500 Hz (1.5g rms)
- Duration = 15 minutes

### 5.2.2 Drops

This simulates off- and on-loading at dispatch and destination, as well as accidental drops during installation. However, it is expected that installers would take more care with expensive metering equipment such as industrial class meters and AMI Concentrators compared to *en masse* installation of less expensive metering equipment such as pre-payment meters.

Therefore, the Test Operator shall liaise with PTM&C to decide whether drop testing is appropriate, and if so, shall perform the test as follows:

- One third of the $n + n_s$ portion of the test sample, i.e., metering equipment units and sub-units labelled in multiples of 3, including spare but excluding extras, in bulk packaging and, where unavoidable, in individual packaging
- 1 metre drop in each of the three planes

## 5.3 Post vibration/drop test

The purpose of this test is to check whether the Vibration and Drop Test (if applicable) has had any adverse effect on the $n + n_s$ portion of the test sample.

a) Check for any broken/loose parts external to the metering equipment units and sub-units, e.g., face plate peeling off, broken circuit breaker toggle, damaged keys, broken scroll button

b) Check whether metering equipment units and sub-units rattle (broken/loose parts inside)

c) Check whether metering equipment powers up

d) Note any abnormal status indication (LED and/or LCD) contrary to operating instructions/manual of metering equipment

e) Check functionality of keys or scroll buttons

f) As applicable, check token entry (for magnetic card reader meters, note ease of token acceptance)

g) As applicable, check whether relevant metering equipment kWh registers increment

h) As applicable, check whether metering equipment credits decrement

i) As applicable, check whether metering equipment trips on zero credits

j) Take two kWh accuracy readings at $U_n$ and $I_b$ (or $I_n$ as applicable)

k) As applicable, check earth leakage operation

**Note:** Any deviations in performance compared to the rest of the test batch

The Test Operator shall record the data for the $n + n_s$ metering equipment units and sub-units according to section 7.

## 5.4 Stress test

The metering equipment shall be subjected to the test parameters as per the following subsections. Temperature/humidity cycling (section 5.4.1) and supply voltage / load current profile (section 5.4.2) applies seven days a week; all other test applications on weekdays only.

In some of the tests below, the applications shall not produce a change in the register of more than *x* kWh, where the value of *x* is derived as follows:

$$x = 10^{-6}\, m\, U_n\, I_{max}$$

where

*m* is the number of measuring elements

$U_n$ is the reference rms voltage in volts

$I_{max}$ is the maximum rms current in amperes

### 5.4.1 Temperature/Humidity cycling

Refer to Figure 1: Environmental Chamber Temperature / Humidity Daily Profile for the daily temperature/humidity profile. Note that relative humidity is not specified for decreasing or sub-zero temperature because, in a typical environmental chamber, the cooling and dehumidifying actions utilise the same refrigeration process and relative humidity is not defined for sub-zero temperature.

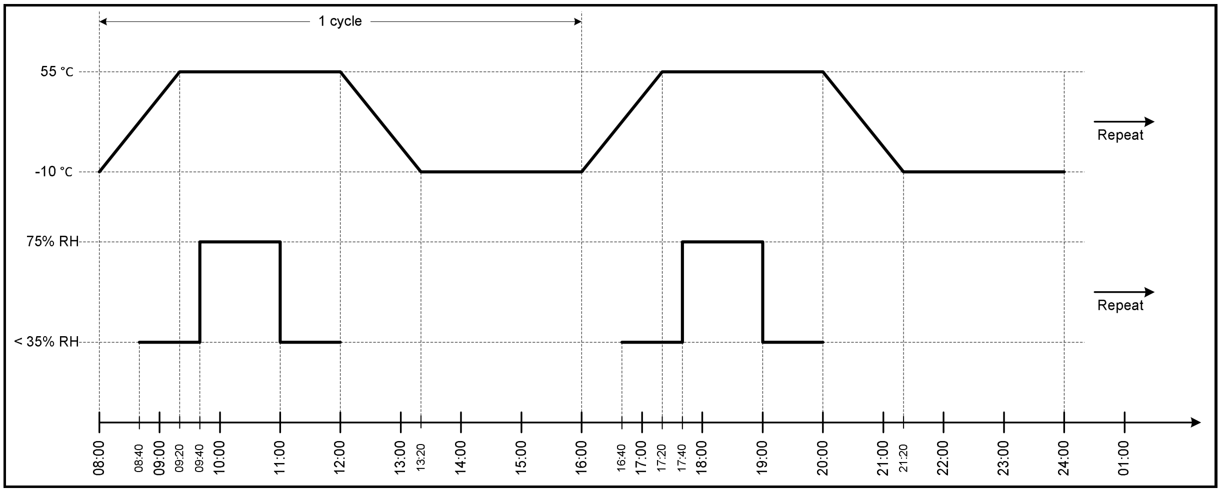


**Figure 1: Environmental Chamber Temperature / Humidity Daily Profile**

### 5.4.2 Supply voltage/load current profile

Refer to Figure 2: Load Current / Supply Voltage Weekly Profile for the weekly supply voltage / load current profile at unity power factor. Note that a minimum of three weeks is required to cover all supply voltage and load current levels. If $I_{max}$ exceeds equipment and/or test set-up capability, accordingly reduced values $kI_{max}$ and $0.1kI_{max}$ may be used, where $0 < k < 1$; this does not affect the value of *x*, as above.

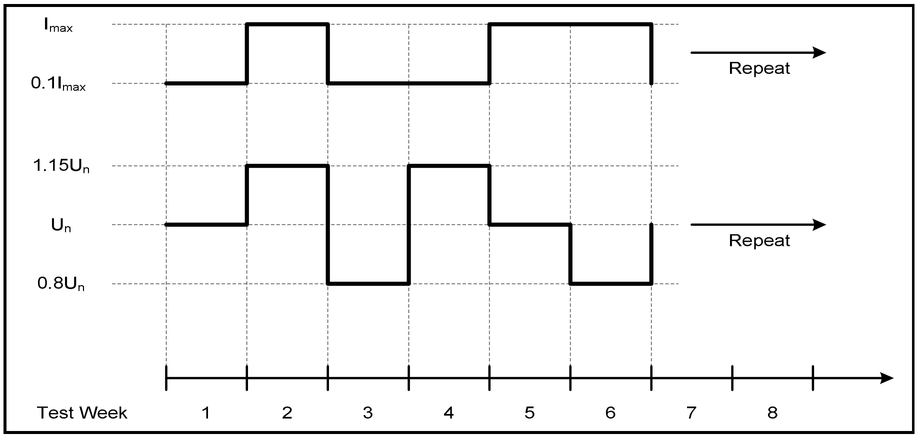


**Figure 2: Load Current / Supply Voltage Weekly Profile**

#### 5.4.2.1 Electrical connections inside environmental chamber

Figures 6.1, 6.2 and 6.3 below illustrate typical setups for the temperature/humidity inside an environmental chamber. The meters, appliance control devices, communication devices, customer interface units and data concentrators (where relevant) shall be fitted onto trollies inside the chamber and wired as per the figures.

The operation of the appliance control devices shall be monitored through the use of counter modules which will be situated outside the chamber. These counter modules will count the number of open or close operations from the appliance control devices and this will be checked against the theoretical number of operations required.

The antennas for communication to the master station, if any, shall be situated outside the test chamber.

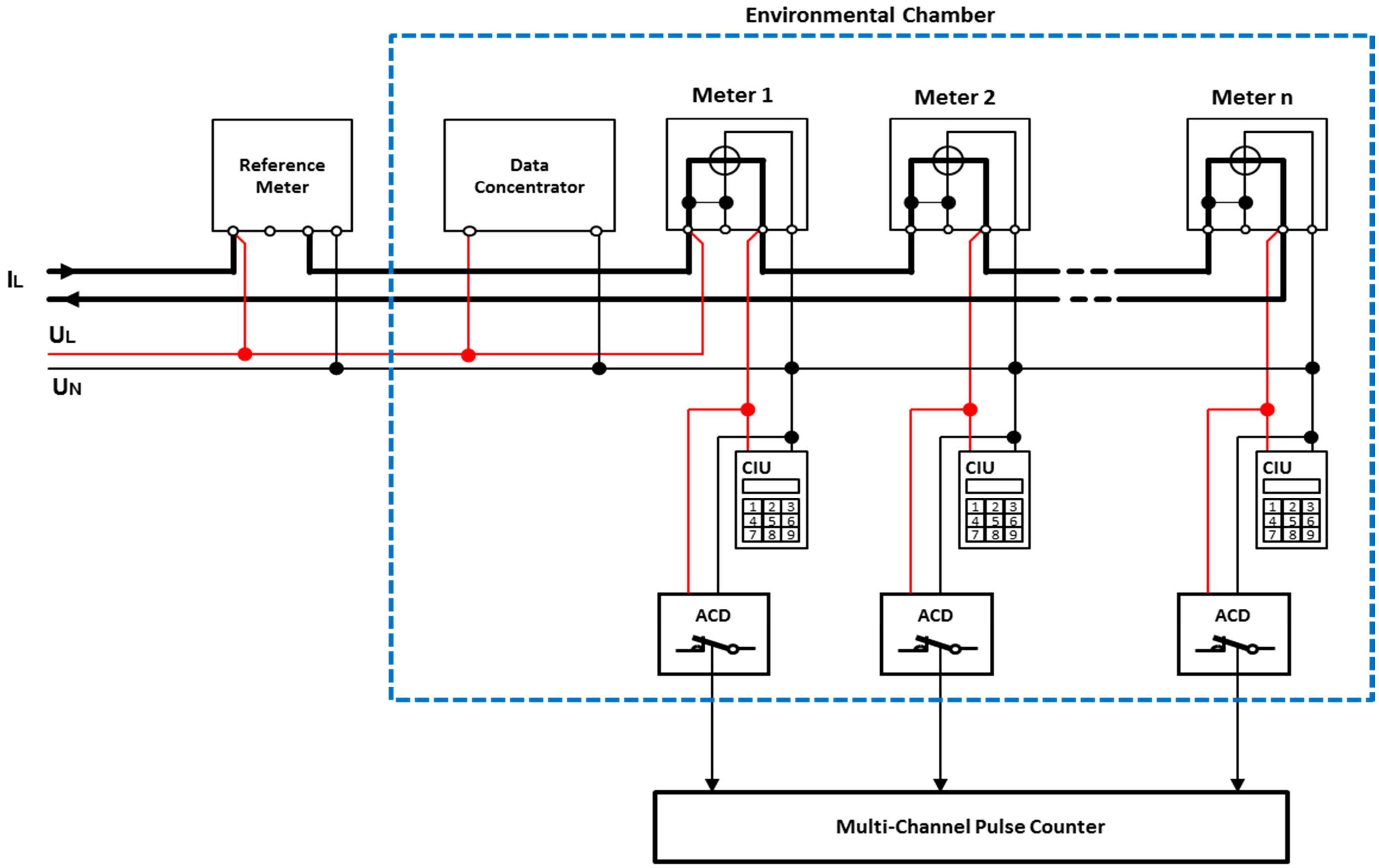


**Figure 3: Typical Environmental chamber setup for single phase whole current meters**

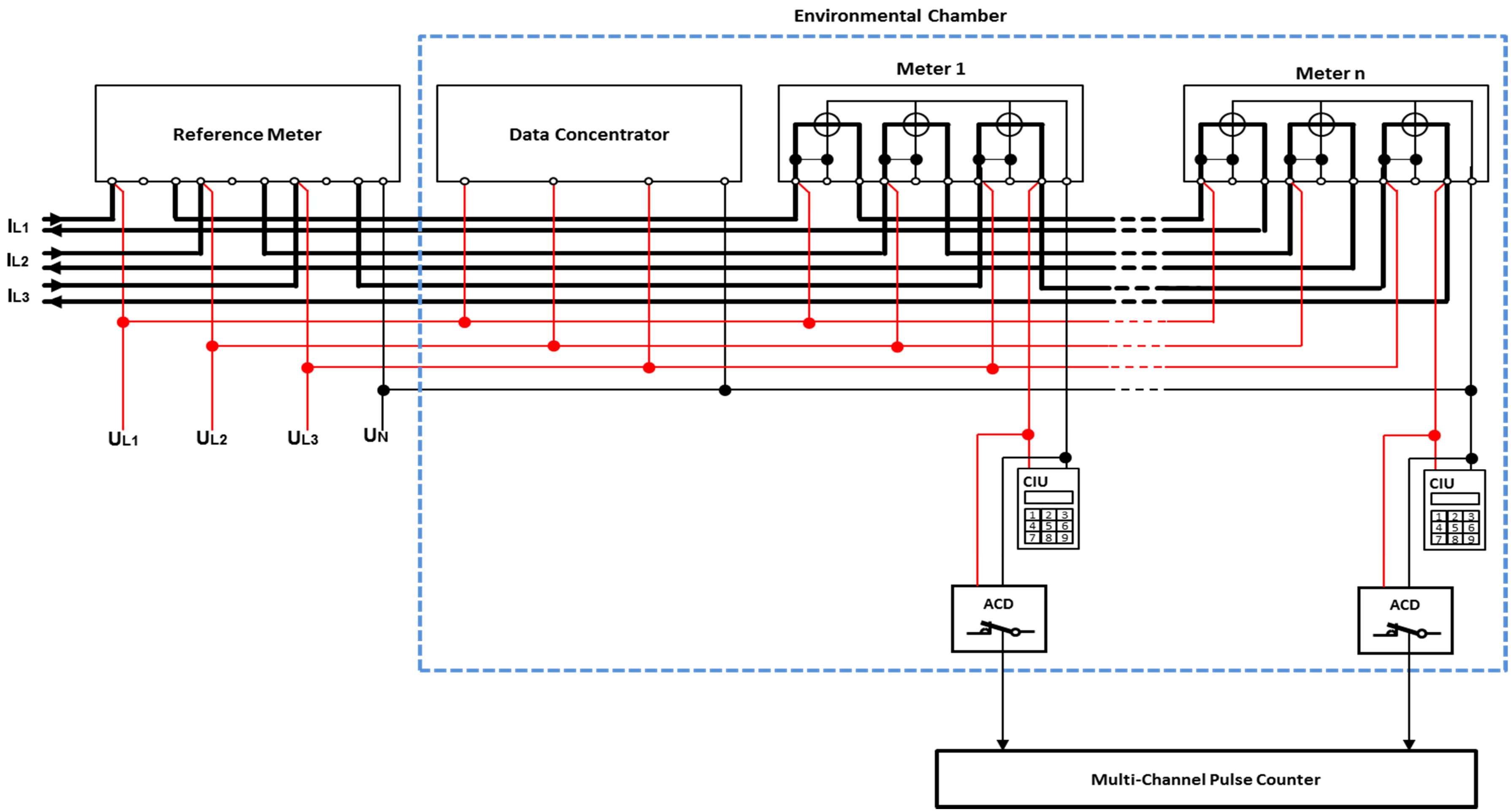


**Figure 4: Typical Environmental chamber setup for three phase whole current meters**

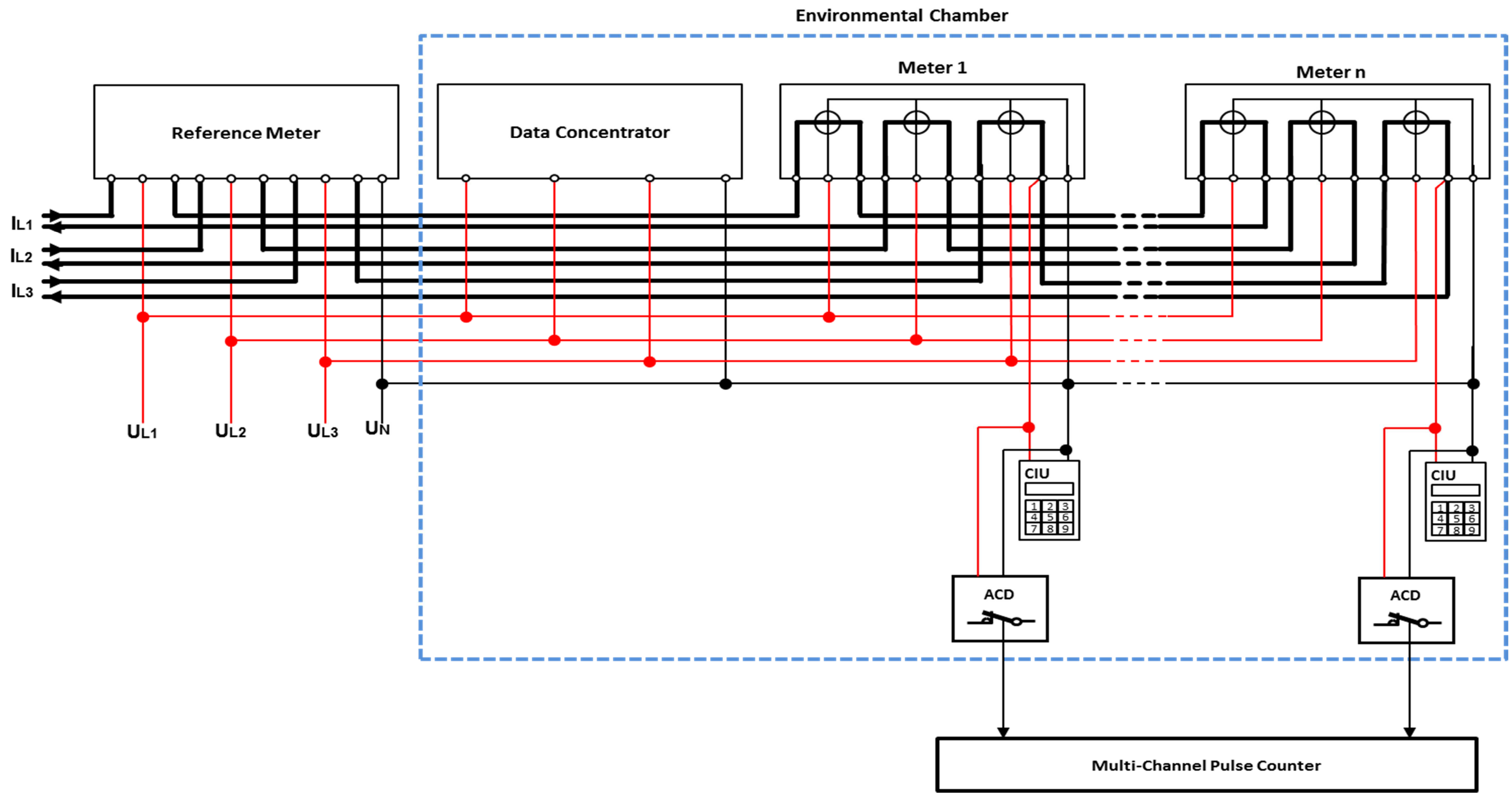


**Figure 5: Typical Environmental chamber setup for three phase CT/VT meters**

### 5.4.3 Sever under-voltage (single phase meters only)

| **PARAMETER** | **DETAIL** |
|---|---|
| Supply voltage | 50% of supply voltage profile (refer to **2**) |
| Load current | None |
| Duration | 1.5 hours |
| Application method | Simultaneously applied to all DUTs in the environmental chamber |
| Application frequency | 3 per DUT per week |
| Test conditions | • As applicable, the DUT disconnect device shall not trip, or shall automatically reconnect<br>• Where applicable, during the test the DUT may refuse user interaction, e.g., token entry, scroll button, etc. – this to be recorded as an event<br>• The application shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10*x* kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• The DUT shall continue to function correctly following the application |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.4 Severe over-voltage (single phase meters only)

| **PARAMETER** | **DETAIL** |
|---|---|
| Supply voltage | $1.73U_n$ |
| Load current | None |
| Duration | 5 hours |
| Application method | Simultaneously applied to all <u>meter</u> DUTs in the environmental chamber |
| Application frequency | 3 per DUT per "$U_n$ week" (refer to **2**) |
| Test conditions | • As applicable, perform a trip test on all DUTs (including appliance control devices) prior to, during and following the application<br>• Where applicable, during the application the DUT may trip and refuse user interaction, e.g., token entry, scroll button, etc. – this to be recorded as an event<br>• The application shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10x kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• The DUT shall continue to function correctly following the application |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.5 Voltage interruptions

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | 0% of supply voltage profile (refer to Figure 5.6) |
| Load current | None |
| Duration | 5 minutes |
| Application method | Simultaneously applied to all DUTs in the environmental chamber |
| Application frequency | 9 per DUT per week |
| Test conditions | • As applicable, the DUT disconnect device shall not trip, or shall automatically reconnect following the application<br>• The application shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10x kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• The DUT shall continue to function correctly following the application |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.6 Voltage dips

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | $\Delta U_1$ = 25%, $\Delta U_2$ = 50%, $\Delta U_3$ = 75% and $\Delta U_4$ = 100% (or similar depending on test equipment availability) of supply voltage profile (refer to **Figure 5.6**) |
| Load current | None |
| Duration | Random between 20 ms and 3 s |
| Application method | Simultaneously applied to all DUTs in the environmental chamber |
| Application frequency | 8 per DUT per week (equally distributed over $\Delta U_1$, $\Delta U_2$, $\Delta U_3$ and $\Delta U_4$) |
| Test conditions | • As applicable, the DUT disconnect device shall not trip, or shall automatically reconnect<br>• The application shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10x kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• The DUT shall continue to function correctly following the application |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.7 Fast transient bursts

| PARAMETER | DETAIL |
|---|---|
| Test voltage | 2 kV (level 3) common-mode, superimposed upon auxiliary supply as per voltage profile (refer to Figure 5.6) |
| Waveform | Pulse bursts: burst duration = 15 ms; pulse repetition rate = 5 kHz; burst period = 300 ms |
| Load current | None |
| Application method | All DUTs removed from environmental chamber – temperature / humidity cycling suspended – and applied individually to each DUT<br>FTB = group of 3 successive 1 s positive applications followed by group of 3 successive 1 s negative applications |
| Application frequency | 3 FTBs per DUT every 2 weeks, i.e., Fridays in weeks 1, 3, 5, 7, ... etc. |
| Test conditions | • Record reaction of DUT to the application<br>• As applicable, the DUT disconnect device shall not trip, or shall automatically reconnect<br>• The application shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10x kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• The DUT shall continue to function correctly following the application |
| Test set-up | As per *Figure E.2* in SANS/IEC62052-11 and *Figure 7* in SANS/IEC61000-4-4 |

### 5.4.8 Electrostatic discharges

| PARAMETER | DETAIL |
|---|---|
| Test voltages | 12 kV using rounded (air discharge) tip |
| Supply voltage | Supply voltage profile (refer to **Figure 5.6**) |
| Load current | None |
| Application method | All DUTs removed from environmental chamber – temperature / humidity cycling suspended – and applied individually to each DUT<br>Applied individually to each DUT having a customer user interface, e.g., keypad, card reader, chip card reader, scroll button, display, etc.: Roving air discharge culminating in contact with DUT user interface |
| Application frequency | <u>Pre-payment meters</u>: 3 ESDs per DUT every 2 weeks<br><u>Credit meters and AMI meters</u>: 1 ESD per DUT every 3 weeks |
| Test conditions | • Record reaction of DUT to application and any discharge to (or into) the DUT<br>• The application shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10x kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• The DUT shall continue to function correctly following the application |
| Test set-up | As per *Figure 4* in SANS/IEC61000-4-2 |

### 5.4.9 Lightning impulses

| **PARAMETER** | **DETAIL** |
|---|---|
| Test voltages | Differential- mode: 4.4 kV asynchronously superimposed upon auxiliary supply as per voltage profile (refer to **Figure 5.6**)<br>Common-mode: 12 kV |
| Waveforms | Differential-mode: Combination wave: 1.2/50 µs voltage across an open circuit, 8/20 µs current into a short circuit, 2 Ω source impedance<br>Common-mode: 1.2/50 µs, 80 Ω source impedance |
| Load current | None |
| Application method | All DUTs removed from environmental chamber – temperature / humidity cycling suspended – and applied individually to each DUT.<br>**Note:** For common-mode application, where applicable the DUT must be tripped; for latch-type pre-payment meters, the credits may need to be cleared using a Clear Credit token.<br>Differential-mode: LI = 3 lightning impulses of same polarity in rapid succession<br>Common-mode: LI = 3 lightning impulses of same polarity in rapid succession |
| Application frequency | Differential-mode: 1 LI per DUT every 2 weeks (alternating polarity), i.e., Fridays in weeks 2 (+), 4 (-), 6 (+), 8 (-), ... etc.<br>Common-mode: 1 LI per DUT every 2 weeks (alternating polarity), i.e., Fridays in weeks 2 (+), 4 (-), 6 (+), 8 (-), ... etc.<br>**Note:** For differential-mode applications to AMI Concentrator DUTs, there are six possible configurations: $L_1$-N, $L_2$-N, $L_3$-N, $L_1$-$L_2$, $L_2$-$L_3$ and $L_3$-$L_1$. These may be selected randomly but an attempt should be made to ensure equal coverage of all configurations. |
| Test conditions | • Record reaction of DUT to application<br>• This test shall not produce a change (as indicated) in the following registers, where applicable:<br>o Date (exceeding 0 days)<br>o Time (exceeding 5 seconds)<br>o Total kWh (current) (exceeding 10x kWh)<br>o Any additional registers as determined through PTM&C liaison<br>• No flashover shall occur in the DUT during the application<br>• The DUT shall continue to function correctly following the application |
| Test set-up | As per *Figures 7* or *9* in IEC61000-4-5 for differential mode applications.<br>As per *Figures 8* or 10 in IEC61000-4-5 for common mode applications.<br>For common mode, the LI is effectively applied across the open disconnect device; this represents the worst-case scenario under common-mode application, e.g., tripped pre-payment or AMImeter during a lightning storm, where the load-side of the meter is coupled – galvanic and/or capacitive – to local earth.<br>In all cases, DUT sub-units must be connected to their respective DUTs if these are included in the AEST being conducted. Note that the load-side of the Appliance Control Device, if applicable, must not be connected to the ground plane, as this would result in unequal stressing of Appliance Control Devices depending on whether or not the meter DUT contains a disconnect device. |

### 5.4.10 Token transfer exercising (STS certified DUTs only)

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | Supply voltage profile (refer to **Figure 5.6**) |
| Load current | None |
| Application method | Applied individually to each DUT in the environmental chamber having a token transfer interface<br>TT = Enter clear credit token followed by 100 kWh credit token |
| Application frequency | 2 TTs per week |
| Test conditions | • Record non-acceptance or difficulty in token acceptance |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.11 Remote data downloading (AMI meters only)

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | Supply voltage profile (refer to Figure 5.6) |
| Load current | Load current profile (refer to Figure 5.6) |
| Application method | Manufacturer/supplier is to download meter DUT consumption data (date- and time-stamped half-hourly kW demand, total registers and events data) up to 24h00 on the previous day and send to the Test Operator in Excel spreadsheet format.<br>Test Operator to record the Total kWh (current) in the provided Excel spreadsheet. |
| Application frequency | Daily before 9h00 |
| Test conditions | • Verify sum of downloaded half-hourly kW demand values against meter kWh total |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.12 Remote supply capacity control (AMI meters only)

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | Supply voltage profile (refer to Figure 5.6) |
| Load current | Load current profile (refer to Figure 5.6) |
| Application method | Monitor the supply capacity of the meter DUT as displayed on the meter or its CIU.<br>Application 1: Ensure loading is below 2 kW. Upon Test Operator request, the manufacturer/supplier is to limit all meters remotely to 2 kW during a pre-arranged time-slot (on-demand load limiting). Upon completion, Test Operator to request manufacturer/supplier to restore the limit of all meters remotely to 20 kW.<br>Application 2: Ensure loading is above 2 kW. Upon Test Operator request, the manufacturer/supplier is to limit the meter remotely to 2 kW for one DUT – randomly selected by the Test Operator – during a pre-arranged time-slot (on-demand load limiting). Upon completion, Test Operator to request manufacturer/supplier to restore the meter limit remotely to 20 kW. |

| PARAMETER | DETAIL |
|---|---|
| Application frequency | Weekly |
| Test conditions | Application 1:<br>• Record whether load limit on DUT meters change to 2 kW and back again<br>Application 2:<br>• Verify that elapsed time between request and completion of operation meets NRS 049 requirements<br>• Verify that contactor disconnects meter when loading is higher than 2 kW |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.13 Remote customer (Dis)connect (AMI meters only)

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | Supply voltage profile (refer to Figure 5.6) |
| Load current | Load current profile (refer to Figure 5.6) |
| Application method | Upon Test Operator request, the manufacturer/supplier is to disconnect and reconnect each meter load switch remotely during a pre-arranged time-slot. As the meters are cascade-connected in the environmental chamber, it is imperative that:<br>a) disconnect sequence is from last meter to first<br>b) reconnect sequence is from first meter to last<br>The Test Operator is to log the elapsed time between request and completion of each operation. |
| Application frequency | Weekly |
| Test conditions | • Verify that meters disconnect/reconnect<br>• Verify that elapsed time meets NRS 049 requirements |
| Test set-up | Refer to section 5.4.2.1 |

### 5.4.14 Remote appliance control device operation (AMI meters only)

| PARAMETER | DETAIL |
|---|---|
| Supply voltage | Supply voltage profile (refer to Figure 5.6) |
| Load current | Load current profile (refer to Figure 5.6) |
| Application method | This test applies to one Appliance Control Device per DUT; each Appliance Control Device is connected to a pulse counter outside the environmental chamber.<br>Application 1: Each meter DUT will switch its Appliance Control Device half-hourly according to its time-of-use schedule (refer to section 4.2.3). The Test Operator is to log the advance of all pulse counters daily.<br>Application 2: Upon Test Operator request, the manufacturer/supplier is to switch the Appliance Control Device remotely for all DUTs during a pre-arranged time-slot (on-demand load switching). The Test Operator is to log the advance of all pulse counters and the elapsed time between request and completion of operation. |

| | |
|---|---|
| | Application 3: Upon Test Operator request, the manufacturer/supplier is to switch the Appliance Control Device remotely for one DUT – randomly selected by the Test Operator – during a pre-arranged time-slot (on-demand load switching). The Test Operator is to log the advance of all pulse counters and the elapsed time between request and completion of operation. |
| Application frequency | Application 1: Half-hourly (automatically, as set up during DUT configuration – refer to section 4.2.3); daily verification.<br>Application 2: Weekly<br>Application 3: Weekly |
| Test conditions | Application 1:<br>• Verify that pulse counter increments match expected number of operations<br>Application 2:<br>• Verify that pulse counter increments match expected number of operations<br>• Verify that elapsed time meets NRS 049 requirements<br>Application 3:<br>• Verify that pulse counter increment matches expected number of operations<br>• Verify that elapsed time meets NRS 049 requirements |
| Test set-up | Refer to section 5.4.2.1 |

## 5.5 Post stress test

The purpose of this test is to check whether the surviving portion of the test batch is still functional and that the registration accuracy is still within the applicable class limits.

a) Check for any broken/loose parts external to the metering equipment units and sub-units, e.g., face plate peeling off, broken circuit breaker toggle, damaged keys, broken scroll button

b) Check whether metering equipment units and sub-units rattle (broken/loose parts inside)

c) Check whether metering equipment powers up

d) Note any abnormal status indication (LED and/or LCD) contrary to operating instructions/manual of metering equipment

e) Check functionality of keys or scroll buttons

f) As applicable, check token entry (for magnetic card reader meters, note ease of token acceptance)

g) As applicable, check whether relevant metering equipment kWh registers increment

h) As applicable, check whether metering equipment credits decrement

i) As applicable, check whether metering equipment trips on zero credits

j) Take two kWh accuracy readings at $U_n$ and $I_b$ (or $I_n$ as applicable)

k) As applicable, check earth leakage operation

**Note:** Any deviations in performance compared to the rest of the test batch

The Test Operator shall record the data for surviving metering equipment units and sub-units according to section 7.

# 6. Test sheets

## 6.1 Overview

This section details various test sheets required by the Test Operator for the conduction of AESTs on solid-state metering equipment.

## 6.2 Failure classification

With an understanding of metering equipment functional behaviour, it is possible to devise a minimal set of major functions. As per IEC 62059-21, a graphical representation of static metering equipment in terms of functional blocks is shown in 6. The following should be noted:

a) The principle of functions is not to be confused with that of subsystems, i.e., a typical function comprises one or more subsystems

b) The “Supply Power (electronics)” functional block is critical to the operation of most other functional blocks, i.e., it serves other functions

c) Functional blocks can be shared by a meter and its sub-units, e.g., split pre-payment meter (meter with separate CIU), or AMI meter with separate CIU, Appliance Control Device and Communications Device

d) Functional blocks are not necessarily all expressed, e.g., AMI Concentrator would exclude the “Disconnect / reconnect” function and may even exclude some other functional blocks

In summary, each of the DUT types may be described in terms of the functional blocks in 6.

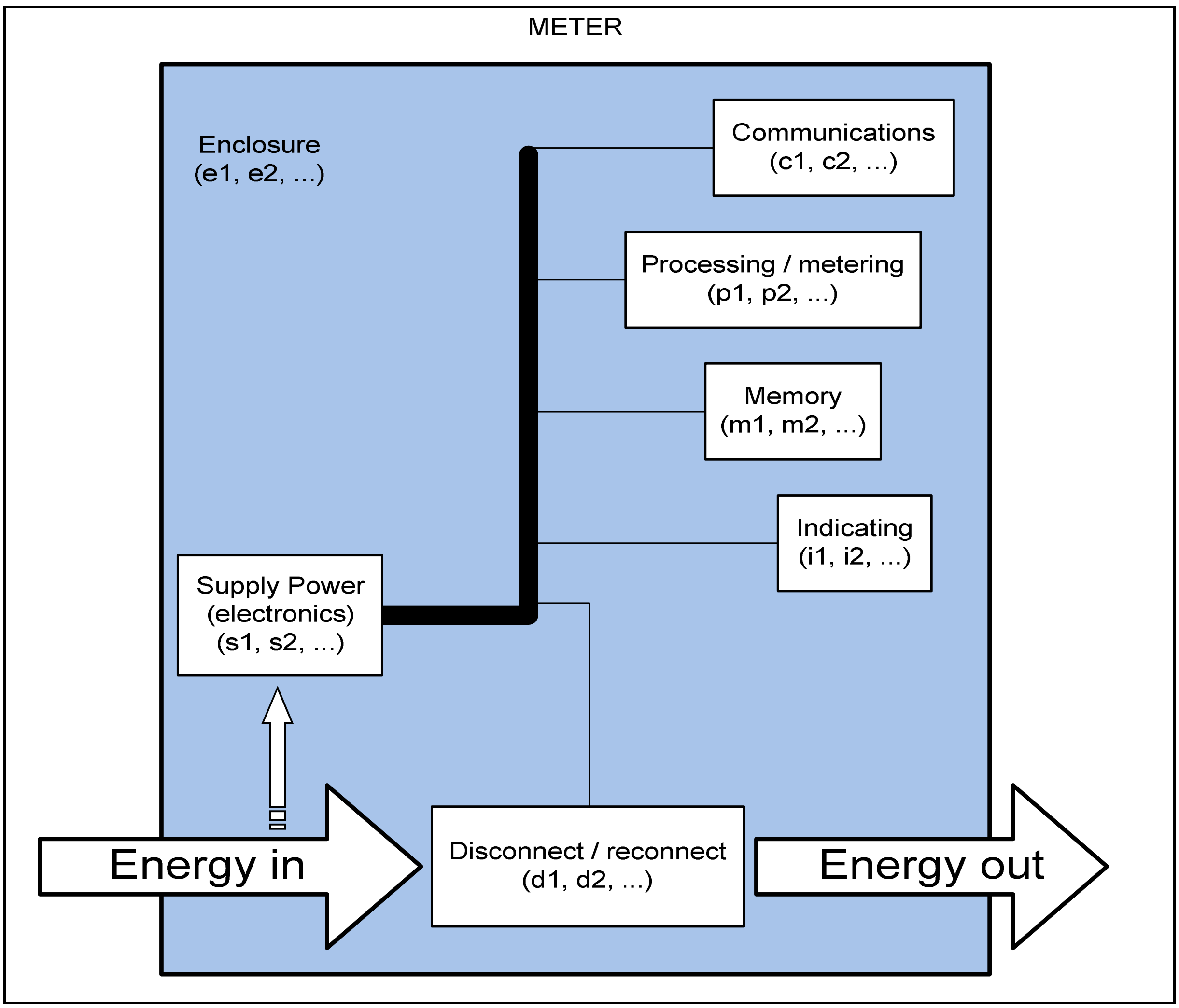


**Figure 6: Static metering equipment functional blocks**

The aim is to classify a failure or event according to one function only i.e. the most likely must be selected through the elimination of other possibilities. Detailed analysis (test laboratory or manufacturer) may lead to a review of the selection. If more than one function is applicable, the failure or event must be described as two or more failures/events and classified separately.

2 gives a detailed definition of each functional block, including typical failures/events. In practice the failure classification comprises an alpha-numeric code in conjunction with a text-string descriptor, as shown in 3.

**Table 2: Functional-level failure classification**

| FAILURE OF... FUNCTION | FUNCTION DEFINITION | CODE | TYPICAL FAILURES/EVENTS |
|---|---|---|---|
| Communications | Communication between user/utility and meter, e.g., token transfer, accessing meter registers, remote reading or interrogation, input or output pulse, test output. | c1… | • Faulty keypad<br>• Faulty scroll button<br>• Failure to communicate via optic port<br>• Failure to communicate via plug-in port |
| Processing / metering | Metering, signal processing, software execution. | p1… | • Register not incrementing<br>• Accuracy out<br>• Software scramble or processor lock-up |
| Memory | Data storage by meter, e.g., consumption register, credit register. | m1… | • Loss of register contents<br>• Sudden change in register contens<br>• Loss of other register contents |
| Indicating | User-interface indicating elements, e.g., light emitting diodes (LED's), liquid crystal display (LCD), beeper or buzzer. | i1… | • LCD (segments) faulty or intermittent<br>• LCD darkens at high temperature but recovers at room temperature<br>• LEDs faulty or intermittent<br>• LEDs too faint<br>• Beeper dead or faint |
| Disconnect / reconnect | Related to power flow, e.g., load control, busbars, and terminal connectors or blocks. | d1… | • Broken, damaged or loose terminals<br>• Auxiliary relay not switching |
| Enclosure | Meter housing, printed circuit board seating, LED light guides, LCD window, faceplate or cover. | e1… | • Buckling<br>• Moisture or vermin ingress<br>• Loose (or broken off) parts<br>• Fractures<br>• Structural flaws<br>• Glue problems<br>• Bad or loose PCB or component seating |
| Supply power (electronics) | Supplies power to all other functions excluding "Enclosure". Includes surge protection components. | s1… | • Meter dead<br>• LCD / LEDs all faint – incorrect power-up / -down thresholds |

**Table 3: Examples of failure classification**

| CODE (alpha-numeric) | DESCRIPTOR (text-string) |
|---|---|
| i1 | Rate LED non-functional |
| i2 | LCD darkens at 55 °C |
| p1 | Metering intermittently |
| e1 | Enclosure buckling |
| p2 | Accuracy = + 3% |
| p3 | Metering very slowly |
| m1 | Load profile (mass memory) corruption |
| p4 | Invalid change in date and/or time |
| c1 | Keypad part-functional |
| s1 | Meter dead – no supply mode |

The specific descriptor codes are never permanently attached to a particular descriptor. These could vary from test to test, as long as the broad classification in the form of the minimal set of functional blocks, i.e., the alpha part of the descriptor code, is followed yielding a “common language”. If it is necessary to compare in detail results between tests, the numeric part of the descriptor codes may be amended, however it should be noted that comparisons are typically made at the functional block level, i.e., the alpha part of the descriptor code.

## 6.3 Report tables

During the conduction of the tests, the test data and failures/events shall be recorded meticulously (typically in a logbook), and classified and tabulated for the test report. 7 to 11 shows examples of the set of tables typically used:

- Time-Line
- Accuracy Readings
- Metering Equipment Tracking Sheet
- Failure/event Frequency Analysis
- Manufacturer (or Supplier) Feedback

For an AMI variant, a set of tables is required for each of the meter DUT and concentrator DUT variants.

It is important that the test operator sets up the Time-Line before the Life Test starts, and then updates the Time-Line on a daily basis to assess test progress.

The Metering Equipment Tracking Sheet includes information about the DUTs, e.g., DUT (unit and its sub-units) removed from chamber for analysis, or sent to manufacturer, etc.

In the Failure/event Frequency Analysis, the failure/event classification descriptor is further subdivided into text-string fields for failure/event, test conditions and remedial action.

**Table X1: Time-Line**

***Variant:*** *ABCMeterMaker 1-phase split pre-payment meter*
**Model:** Example
**H/W ver:** 1.00
**S/W ver:** 1.00
**Test batch:** 1302-ABC1-MET-01 to 27

| DATE | WEEK | TEST | CHAMBER | NO. IN | CUMULATIVE | V | I | TOKEN | TRIP | DIP | | | | INT | U- | FTB | | O- | ESD | LI (DIFF) | | LI (COM) | | GENERAL COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DAY | DAY | HOURS | CHAMBER | YEARS | (V) | (A) | ENTRY | TEST | $\Delta U_1$ | $\Delta U_2$ | $\Delta U_3$ | $\Delta U_4$ | | VOLT | + | - | VOL | | + | - | + | - | |
| 01-Jul-13 | Mon | **PQ** | | | | | | | | | | | | | | | | | | | | | | |
| 02-Jul-13 | Tue | **PQ** | | | | | | | | | | | | | | | | | | | | | | |
| 03-Jul-13 | Wed | **VD** | | | | | | | | | | | | | | | | | | | | | | |
| 04-Jul-13 | Thu | **PVD** | | | | | | | | | | | | | | | | | | | | | | |
| 05-Jul-13 | Fri | **PVD** | | | | | | | | | | | | | | | | | | | | | | |
| 09-Jul-13 | Tue | **1** | 8 | 21 | **0.06** | 230 | 1.5 | 1 | | 1 | | 1 | | 3 | 1 | | | 1 | 1 | | | | | Meters installed in chamber; test commenced at 16:00 |
| 10-Jul-13 | Wed | **2** | 24 | 21 | **0.23** | | | | | | 2 | | | 3 | | | | 1 | | | | | | |
| 11-Jul-13 | Thu | **3** | 24 | 21 | **0.40** | | | 1 | | 1 | | 1 | | 3 | 1 | | | 1 | | | | | | |
| 12-Jul-13 | Fri | **4** | 24 | 21 | **0.58** | | | | | | | | | | | 3 | 3 | | | | | | | |
| 13-Jul-13 | Sat | **5** | 24 | 21 | **0.75** | | | | | | | | | | | | | | | | | | | |
| 14-Jul-13 | Sun | **6** | 24 | 21 | **0.92** | | | | | | | | | | | | | | | | | | | |
| 15-Jul-13 | Mon | **7** | 24 | 21 | **1.09** | 264 | 15 | 1 | | | 1 | 1 | | 3 | 1 | | | | 1 | | | | | |
| 16-Jul-13 | Tue | **8** | 24 | 21 | **1.27** | | | | | 1 | | 1 | | 3 | | | | | | | | | | |
| 17-Jul-13 | Wed | **9** | 24 | 21 | **1.44** | | | | | | 1 | | 1 | 3 | 1 | | | | | | | | | |
| 18-Jul-13 | Thu | **10** | 24 | 21 | **1.61** | | | 1 | | 1 | | | 1 | | 1 | | | | 1 | | | | | |
| 19-Jul-13 | Fri | **11** | 24 | 21 | **1.78** | | | | | | | | | | | | | | | 1 | | 1 | | |
| 20-Jul-13 | Sat | **12** | 8 | 21 | **1.84** | | | | | | | | | | | | | | | | | | | Chamber tripped |
| 21-Jul-13 | Sun | **13** | 0 | 21 | **1.84** | | | | | | | | | | | | | | | | | | | |
| 22-Jul-13 | Mon | **14** | 0 | 0 | **1.84** | 184 | 1.5 | | | | | | | | | | | | | | | | | Meters removed for chamber repair |
| 26-Jul-13 | Fri | **15** | 12 | 21 | **1.93** | | | | | | | | | | | | | | | | | | | Chamber repair complete |
| 27-Jul-13 | Sat | **16** | 24 | 21 | **2.10** | | | | | | | | | | | | | | | | | | | |
| 28-Jul-13 | Sun | **17** | 24 | 21 | **2.27** | | | | | | | | | | | | | | | | | | | |
| 29-Jul-13 | Mon | **18** | 24 | 21 | **2.45** | 184 | 1.5 | 1 | | | 1 | | | 3 | 1 | | | | | | | | | |
| 30-Jul-13 | Tue | **19** | 24 | 21 | **2.62** | | | | | | 1 | | 1 | 3 | | | | | | | | | | |
| 31-Jul-13 | Wed | **20** | 24 | 21 | **2.79** | | | | | 1 | | 1 | 1 | 3 | 1 | | | | 1 | | | | | |
| 01-Aug-13 | Thu | **21** | 24 | 21 | **2.96** | | | 1 | | 1 | | 1 | | | 1 | | | | | | | | | |
| 02-Aug-13 | Fri | **22** | 24 | 21 | **3.14** | | | | | | | | | | | 3 | 3 | | | | | | | |
| 03-Aug-13 | Sat | **23** | 24 | 21 | **3.31** | | | | | | | | | | | | | | | | | | | |
| 04-Aug-13 | Sun | **24** | 24 | 21 | **3.48** | | | | | | | | | | | | | | | | | | | |
| 05-Aug-13 | Mon | **25** | 24 | 21 | **3.65** | 264 | 1.5 | 1 | | 1 | 1 | | | 3 | 1 | | | | 1 | | | | | |
| 06-Aug-13 | Tue | **26** | 24 | 21 | **3.83** | | | | | 1 | 1 | 1 | | 3 | | | | | | | | | | |
| 07-Aug-13 | Wed | **27** | 24 | 21 | **4.00** | | | | | | | 1 | 1 | 3 | 1 | | | | | | | | | |
| 08-Aug-13 | Thu | **28** | 24 | 21 | **4.17** | | | 1 | | | | | 1 | | 1 | | | | 1 | | | | | |
| 09-Aug-13 | Fri | **29** | 24 | 21 | **4.34** | | | | | | | | | | | | | | | | 1 | | 1 | |
| 10-Aug-13 | Sat | **30** | 24 | 21 | **4.52** | | | | | | | | | | | | | | | | | | | |
| 11-Aug-13 | Sun | **31** | 24 | 21 | **4.69** | | | | | | | | | | | | | | | | | | | |
| 12-Aug-13 | Mon | **32** | 24 | 20 | **4.85** | 230 | 15 | 1 | | 1 | | | 1 | 3 | 1 | | | 1 | 1 | | | | | |
| 13-Aug-13 | Tue | **33** | 24 | 20 | **5.02** | | | | | | 1 | 1 | | 3 | | | | 1 | | | | | | |
| 14-Aug-13 | Wed | **34** | 24 | 20 | **5.18** | | | | | | 1 | | 1 | 3 | 1 | | | 1 | | | | | | |
| 15-Aug-13 | Thu | **35** | 24 | 19 | **5.34** | | | 1 | | 1 | | 1 | | | 1 | | | | 1 | | | | | |
| 16-Aug-13 | Fri | **36** | 24 | 19 | **5.49** | | | | | | | | | | | 3 | 3 | | | | | | | |
| 17-Aug-13 | Sat | **37** | 24 | 19 | **5.65** | | | | | | | | | | | | | | | | | | | |
| 18-Aug-13 | Sun | **38** | 24 | 19 | **5.81** | | | | | | | | | | | | | | | | | | | |
| 19-Aug-13 | Mon | **39** | 24 | 19 | **5.96** | 184 | 15 | 1 | | 2 | | | | 3 | 1 | | | | | | | | | |
| 20-Aug-13 | Tue | **40** | 24 | 19 | **6.12** | | | | | | 1 | 1 | | 3 | | | | | | | | | | |
| 21-Aug-13 | Wed | **41** | 24 | 19 | **6.28** | | | | | 1 | | 1 | | 3 | 1 | | | | 1 | | | | | |
| 22-Aug-13 | Thu | **42** | 24 | 19 | **6.43** | | | 1 | | | | 1 | 1 | | 1 | | | | | | | | | |
| 23-Aug-13 | Fri | **43** | 16 | 19 | **6.54** | | | | | | | | | | | | | | | 1 | | 1 | | |
| 24-Aug-13 | Sat | **44** | 0 | 19 | **6.54** | | | | | | | | | | | | | | | | | | | Planned building power outage |
| 25-Aug-13 | Sun | **45** | 0 | 19 | **6.54** | | | | | | | | | | | | | | | | | | | |
| 26-Aug-13 | Mon | **46** | 16 | 19 | **6.64** | 230 | 1.5 | 1 | | 1 | 1 | | | 3 | 1 | | | 1 | | | | | | |
| 27-Aug-13 | Tue | **47** | 24 | 19 | **6.80** | | | | | | 1 | 1 | | 3 | | | | 1 | 1 | | | | | |
| 28-Aug-13 | Wed | **48** | 24 | 19 | **6.95** | | | | | | | 1 | 1 | 3 | 1 | | | 1 | | | | | | |
| 29-Aug-13 | Thu | **49** | 24 | 19 | **7.11** | | | 1 | | | | 1 | 1 | | 1 | | | | | | | | | |
| 30-Aug-13 | Fri | **50** | 24 | 19 | **7.26** | | | | | | | | | | | 3 | 3 | | | | | | | |
| 31-Aug-13 | Sat | **51** | 24 | 19 | **7.42** | | | | | | | | | | | | | | | | | | | |
| 01-Sep-13 | Sun | **52** | 24 | 19 | **7.58** | | | | | | | | | | | | | | | | | | | |
| 02-Sep-13 | Mon | **53** | 24 | 19 | **7.73** | 264 | 15 | 1 | | | 1 | 1 | | 3 | 1 | | | | 1 | | | | | |
| 03-Sep-13 | Tue | **54** | 24 | 19 | **7.89** | | | | | | 1 | | 1 | 3 | | | | | | | | | | |
| 04-Sep-13 | Wed | **55** | 24 | 19 | **8.05** | | | | | | | 1 | 1 | 3 | 1 | | | | | | | | | |
| 05-Sep-13 | Thu | **56** | 24 | 18 | **8.19** | | | 1 | | 1 | | | 1 | | 1 | | | | 1 | | | | | |
| 06-Sep-13 | Fri | **57** | 24 | 18 | **8.34** | | | | | | | | | | | | | | | | 1 | | 1 | |
| 07-Sep-13 | Sat | **58** | 24 | 18 | **8.49** | | | | | | | | | | | | | | | | | | | |
| 08-Sep-13 | Sun | **59** | 24 | 18 | **8.64** | | | | | | | | | | | | | | | | | | | |
| 09-Sep-13 | Mon | **60** | 24 | 18 | **8.78** | 184 | 1.5 | 1 | | 1 | 1 | | | 3 | 1 | | | | 1 | | | | | |
| 10-Sep-13 | Tue | **61** | 24 | 18 | **8.93** | | | | | | 1 | 1 | | 3 | | | | | | | | | | |
| 11-Sep-13 | Wed | **62** | 24 | 18 | **9.08** | | | | | | | 1 | 1 | 3 | 1 | | | | | | | | | |
| 12-Sep-13 | Thu | **63** | 24 | 18 | **9.23** | | | 1 | | | | 1 | 1 | | 1 | | | | 1 | | | | | |
| 13-Sep-13 | Fri | **64** | 24 | 18 | **9.38** | | | | | | | | | | | 3 | 3 | | | | | | | |
| 14-Sep-13 | Sat | **65** | 24 | 18 | **9.52** | | | | | | | | | | | | | | | | | | | |
| 15-Sep-13 | Sun | **66** | 24 | 18 | **9.67** | | | | | | | | | | | | | | | | | | | |
| 16-Sep-13 | Mon | **67** | 24 | 18 | **9.82** | 264 | 1.5 | 1 | | 1 | | | 1 | 3 | 1 | | | | 1 | | | | | |
| 17-Sep-13 | Tue | **68** | 24 | 18 | **9.97** | | | | | | 1 | 1 | | 3 | 1 | | | | | | | | | |
| 18-Sep-13 | Wed | **69** | 8 | 18 | **10.02** | | | | | 1 | | 1 | | | | | | | | | | | | Life Test completed at 8:00 |
| 19-Sep-13 | Thu | **PL** | | | | | | | | | | | | | | | | | | | | | | |
| 20-Sep-13 | Fri | **PL** | | | | | | | | | | | | | | | | | | | | | | |
| *CUMULATIVE TOTALS* | | | 1484 | | **10.02** | | | 19 | 0 | 18 | 18 | 23 | 17 | 87 | 28 | 15 | 15 | 9 | 15 | 2 | 2 | 2 | 2 | |

**Figure 7: Example of Time-Line**

**Table X2:** **Accuracy Readings**

***Variant:*** *ABCMeterMaker 1-phase split pre-payment meter*
**Model:** Example
**H/W ver:** 1.00
**S/W ver:** 1.00
**Test batch:** 1302-ABC1-MET-01 to 27

< >

| METERING EQUIP LABEL | SERIAL NUMBER | PRE-Q | | POST-VD | | POST-L | |
|---|---|---|---|---|---|---|---|
| | | %ERR 1 | %ERR 2 | %ERR 1 | %ERR 2 | %ERR 1 | %ERR 2 |
| ABC1-MET-01 | 1000002 | -0.4 | -0.4 | -0.5 | -0.6 | -0.5 | -0.5 |
| ABC1-MET-02 | 1000023 | -0.7 | -0.7 | -0.7 | -0.6 | -0.7 | -0.6 |
| ABC1-MET-03 | 1000100 | -0.2 | -0.1 | -0.2 | -0.2 | -0.2 | -0.2 |
| ABC1-MET-04 | 1000104 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| ABC1-MET-05 | 1000253 | -0.7 | -0.6 | -0.6 | -0.6 | -0.6 | -0.6 |
| ABC1-MET-06 | 1000333 | -0.5 | -0.5 | -0.5 | -0.5 | 2.1 | 2.1 |
| ABC1-MET-07 | 1000365 | -0.5 | -0.4 | -0.4 | -0.5 | -0.6 | -0.5 |
| ABC1-MET-08 | 1000501 | -0.4 | -0.4 | -0.3 | -0.3 | 3.0 | 2.9 |
| ABC1-MET-09 | 1000522 | -0.6 | -0.6 | -0.6 | -0.5 | -0.6 | -0.6 |
| ABC1-MET-10 | 1000543 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.3 |
| ABC1-MET-11 | 1000633 | -0.2 | -0.2 | -0.2 | -0.2 | 2.3 | 2.3 |
| ABC1-MET-12 | 1000798 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| ABC1-MET-13 | 1000801 | -0.7 | -0.7 | -0.6 | -0.6 | -0.6 | -0.6 |
| ABC1-MET-14 | 1000956 | -0.2 | -0.2 | -0.2 | -0.2 | -0.6 | -0.6 |
| ABC1-MET-15 | 1000978 | 0.0 | 0.0 | 0.1 | 0.1 | 2.9 | 2.8 |
| ABC1-MET-16 | 1000998 | -0.3 | -0.2 | -0.2 | -0.2 | 2.4 | 2.4 |
| ABC1-MET-17 | 1001020 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.5 |
| ABC1-MET-18 | 1001178 | -0.5 | -0.4 | -0.5 | -0.6 | -0.7 | -0.7 |
| ABC1-MET-19 | 1001250 | -0.2 | -0.2 | -0.2 | -0.2 | -0.3 | -0.3 |
| ABC1-MET-20 | 1001279 | -0.6 | -0.6 | -0.7 | -0.7 | -0.6 | -0.6 |
| ABC1-MET-21 | 1001345 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 |
| ABC1-MET-22 | 1001400 | -0.4 | -0.5 | -0.5 | -0.5 | -0.4 | -0.4 |
| ABC1-MET-23 | 1001588 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 |
| ABC1-MET-24 | 1001634 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |
| ABC1-MET-25 | 1001688 | 0.0 | 0.0 | -0.1 | -0.1 | -0.1 | -0.2 |
| ABC1-MET-26 | 1001732 | -0.1 | -0.2 | -0.2 | -0.1 | -0.2 | -0.2 |
| ABC1-MET-27 | 1001895 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |

**Figure 8: Example of Accuracy Readings**

**Table X3: Meter Tracking Sheet**

***Variant:*** *ABCMeterMaker 1-phase split pre-payment meter*
**Model:** Example
**H/W ver:** 1.00
**S/W ver:** 1.00
**Test batch:** 1302-ABC1-MET-01 to 27

| METERING | TEST DAYS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EQUIP LABEL | PQ | PQ | V | D | PVD | PVD | 0 | 4 | 4 | 11 | 11 | 15 | 16 | 18 | 20 | 23 | 33 | 33 | 35 | 48 | 48 | 49 | 49 | 59 | 64 | 67 | 67 | PL | PL | PL |
| ABC1-MET-01 | | | V | | | | C | | | d1 | A | M | | | | | | | | | | | | | | | | | | |
| ABC1-MET-02 | | | V | | | | C | | | | | | | | | | d2 | A | M | | | | | | | | | | | |
| ABC1-MET-03 | | | V | D | | | C | | | | | | | | | i2 | d2 | A | M | | | | | | | | | | | |
| ABC1-MET-04 | | | V | | | | C | | | | | | | | | | | | | d2 | A | | | M | | | | | | |
| ABC1-MET-05 | | | V | | | | C | c2 | A | | | M | | | | | | | | | | | | | | S | C | | | |
| ABC1-MET-06 | | | V | D | | | C | | | | | | | | | | | | | | | | | | | | | p2 | A | M |
| ABC1-MET-07 | c1 | | V | | | | C | | | | | e1 | | | | | | | | | | | | | | | | | | |
| ABC1-MET-08 | | | V | | | | C | | | | | | | | | | | | | | | | | | | | | p2 | A | M |
| ABC1-MET-09 | | | V | D | | | C | | | | | | | | | | | | | | | c2 | A | M | | | | | | |
| ABC1-MET-10 | | | V | | | | C | | | | | | | | c3 | | | | | | | | | | | | | | | |
| ABC1-MET-11 | | | V | | | | C | | | | | | | e1 | | | | | | | | | | | | | | p2 | A | M |
| ABC1-MET-12 | | | V | D | | | C | | | | | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-13 | | | V | | | | C | | | | | | i1 | A | | | | | M | | | | | | | | | | | |
| ABC1-MET-14 | | | V | | | | C | | | | | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-15 | | | V | D | | | C | | | | | | | p1 | | | | | | | | | | | | | | p2 | A | M |
| ABC1-MET-16 | | | V | | | | C | | | | | | | | | | | | | | | | | | | | | p2 | A | M |
| ABC1-MET-17 | | | V | | | | C | | | | | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-18 | | | V | D | | | C | | | | | | | | c3 | | | | | | | | | | m1 | A | M | | | |
| ABC1-MET-19 | c2 | | | | | A | | | | | | M | | | | | | | | | | | | | | | | | | |
| ABC1-MET-20 | | | V | | | | C | | | | | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-21 | | | V | D | | | C | | | | | | | | | | | | | | | s1 | A | M | | | | | | |
| ABC1-MET-22 | | | V | | | | C | | | | | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-23 | | | V | | | | S | | C | d1 | | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-24 | | | V | D | | | S | | | | | | | | | | | C | | | | | | | | | | | | |
| ABC1-MET-25 | | | V | | | | S | | | | C | | | | | | | | | | | | | | | | | | | |
| ABC1-MET-26 | | | V | | | | S | | | | | | | C | | | | | | | | | | | | | | | | |
| ABC1-MET-27 | | | V | D | | | S | | | | | | | | | | | C | | | | | | | | | | | | |
| **DAY TOTALS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **V/D'd** | | | 26 | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Analysis** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 5 | 0 |
| **Chamber** | | | | | | | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 20 | 20 | 18 | 18 | 18 | 17 | 18 | | | |
| **Spare** | | | | | | | 5 | 5 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | | |
| ***Warning*** | | | | | | | | | | | | | | | | | | | | | | | | | | S!! | | | | |
| **CUMULATIVE TOTALS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Analysis** | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 7 | 7 | 9 | 9 | 9 | 10 | 10 | 10 | 15 | 15 |
| **To Manuf.** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 6 | 6 | 6 | 6 | 6 | 9 | 9 | 9 | 10 | 10 | 10 | 15 |
| To be sent | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 1 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 5 | 0 |
| Repaired | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |

**Figure 9: Example of Metering Equipment Tracking Sheet**

**Table X4: Failure/event Frequency Analysis**

***Variant:*** *ABCMeterMaker 1-phase split pre-payment meter*
**Model:** Example
**H/W ver:** 1.00
**S/W ver:** 1.00
**Test batch:** 1302-ABC1-MET-01 to 27

| METERING EQUIP LABEL | FAILURE / EVENT DESCRIPTION | | | | | | | | | | | | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | c1 | c2 | c3 | i1 | i2 | m1 | s1 | e1 | d1 | d2 | p1 | p2 | |
| ABC1-MET-01 | | | | | | | | | 1 | | | | 1 |
| ABC1-MET-02 | | | | | | | | | | 1 | | | 1 |
| ABC1-MET-03 | | | | | 1 | | | | | 1 | | | 2 |
| ABC1-MET-04 | | | | | | | | | | 1 | | | 1 |
| ABC1-MET-05 | | 1 | | | | | | | | | | | 1 |
| ABC1-MET-06 | | | | | | | | | | | | 1 | 1 |
| ABC1-MET-07 | 1 | | | | | | | 1 | | | | | 2 |
| ABC1-MET-08 | | | | | | | | | | | | 1 | 1 |
| ABC1-MET-09 | | 1 | | | | | | | | | | | 1 |
| ABC1-MET-10 | | | 1 | | | | | | | | | | 1 |
| ABC1-MET-11 | | | | | | | | 1 | | | | 1 | 2 |
| ABC1-MET-12 | | | | | | | | | | | | | |
| ABC1-MET-13 | | | | 1 | | | | | | | | | 1 |
| ABC1-MET-14 | | | | | | | | | | | | | |
| ABC1-MET-15 | | | | | | | | | | | 1 | 1 | 2 |
| ABC1-MET-16 | | | | | | | | | | | | 1 | 1 |
| ABC1-MET-17 | | | | | | | | | | | | | |
| ABC1-MET-18 | | | 1 | | | 1 | | | | | | | 2 |
| ABC1-MET-19 | | 1 | | | | | | | | | | | 1 |
| ABC1-MET-20 | | | | | | | | | | | | | |
| ABC1-MET-21 | | | | | | | 1 | | | | | | 1 |
| ABC1-MET-22 | | | | | | | | | | | | | |
| ABC1-MET-23 | | | | | | | | | 1 | | | | 1 |
| ABC1-MET-24 | | | | | | | | | | | | | |
| ABC1-MET-25 | | | | | | | | | | | | | |
| ABC1-MET-26 | | | | | | | | | | | | | |
| ABC1-MET-27 | | | | | | | | | | | | | |
| **TOTALS** | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 5 | 23 |
| Failure or event: | Not accepting meter-specific tokens | Not accepting any tokens | Difficulty accepting meter-specific tokens | Dead segments in LCD | Beeper volume too low | Change in credit register (-10 units) | Meter dead | Glue loosened around LCD | Not tripping on Earth Leakage condition | Not tripping on zero credits | Garbled information displayed | Accuracy out | |
| Test conditions: | 15-30 degC, 230 V | 230 V | <45 degC, 184 V | General | General | 0-15 degC, 184 V, supply interruption | >45 degC, 400 V | General | 0-15 degC, 264 V | 0-15 degC, 230 V | 0-15 degC, 184 V | General | |
| Remedial action: | Stuck key loosened | None | Recovered at room temperature | None | None | None | None | None | None | Reset | Power supply toggled | None | |
| | c1 | c2 | c3 | i1 | i2 | m1 | s1 | e1 | d1 | d2 | p1 | p2 | |

**Figure 10: Example of Failure/event Frequency Analysis**

**Table X5:** **Manufacturer (or Supplier) Feedback**

***Variant:*** *ABCMeterMaker 1-phase split pre-payment meter*
**Model:** Example
**H/W ver:** 1.00
**S/W ver:** 1.00
**Test batch:** 1302-ABC1-MET-01 to 27

AutoFit

| METERING EQUIP LABEL | MANUFACTURER (SUPPLIER) LABORATORY REPORT |
|---|---|
| ABC1-MET-01 | |
| ABC1-MET-02 | |
| ABC1-MET-03 | |
| ABC1-MET-04 | |
| ABC1-MET-05 | |
| ABC1-MET-06 | |
| ABC1-MET-07 | |
| ABC1-MET-08 | |
| ABC1-MET-09 | |
| ABC1-MET-10 | |
| ABC1-MET-11 | |
| ABC1-MET-12 | |
| ABC1-MET-13 | |
| ABC1-MET-14 | |
| ABC1-MET-15 | |
| ABC1-MET-16 | |
| ABC1-MET-17 | |
| ABC1-MET-18 | |
| ABC1-MET-19 | |
| ABC1-MET-20 | |
| ABC1-MET-21 | |
| ABC1-MET-22 | |
| ABC1-MET-23 | |
| ABC1-MET-24 | |
| ABC1-MET-25 | |
| ABC1-MET-26 | |
| ABC1-MET-27 | |

**Figure 11: Example of Manufacturer (or Supplier) Feedback**

## 7. Authorization

This document has been seen and accepted by:

| Name and surname | Designation |
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## 8. Revisions

| Date | Rev | Compiler | Remarks |
|---|---|---|---|
| March 2016 | 2 | KS Papi | Change of document structure<br>Consolidation of test requirements for all meter types under M&M SC<br>Updated chamber connection diagrams |
| Nov 2013 | 1 | AJ Koert | Original document drawn from RES/RR/00/11740<br>Various corrections |

## 9. Development team

The following people were involved in the development of this document:

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## 10. Acknowledgements

Not applicable.