ALTERNATIVE TESTING AND INSPECTION GUIDELINES FOR METERING INSTALLATIONS IN THE NEM

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VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
0.1	26 January 2012	Initial draft release for the inspection, maintenance and testing of low voltage current transformer metering installation(s).
0.2	21 March 2012	Incorporated CTTWG feedback, technical review and following the review by independent experts.
1.0	04 April 2012	First live final version.
1.1	03 May 2012	Updated document to include all LV CTs as part of sample testing, with associated changes to the inspection requirements. Also new paragraph in section 6 for submission of results.
2.0 draft	31 October 2019	Draft version - Updated to new AEMO template and rewritten to reflect changes based on first round of testing.
2.0	10 March 2020	Second final live version - Minor clarity tweaks and suggested changes implemented from feedback received from MCs.

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1. INTRODUCTION

1.1. Purpose and scope

These Alternative Testing Guidelines for Metering Installations in the NEM provide a guideline for any Metering Coordinator (MC) seeking to apply to AEMO for approval of an asset management strategy that defines an alternative testing practice under NER clause S7.6 (Guidelines).

However, these Guidelines do not apply to an asset management strategy to the extent the strategy applies to whole current meters.

For the avoidance of doubt, the guidelines in section 8 of Metrology Procedure Part A apply to asset management strategies for all meter types including whole current meters.

These Guidelines have effect only for the purposes set out in the National Electricity Rules (NER). The NER and the National Electricity Law and the Retail Electricity Market Procedures prevail over these Guidelines to the extent of any inconsistency.

These Guidelines outline technical and operational requirements in the inspection, maintenance and testing of low voltage *current transformer metering installations* (LV CT) by a MC.

There is no obligation for an MC to adopt the strategy or practices in these Guidelines. An MC may develop an asset management strategy other than as specified in these Guidelines and seek approval of that strategy from AEMO in accordance with the requirements of NER clause S7.6.

1.2. Definitions and interpretation

1.2.1. Glossary

Terms defined in the National Electricity Law and the NER have the same meanings in these Guidelines unless otherwise specified in this clause.

Terms defined in the NER are intended to be identified in these Guidelines by italicising them, but failure to italicise a defined term does not affect its meaning.

1.2.2. Interpretation

In this document diagrams are provided as an overview. If there are ambiguities between a diagram and the text, the text shall take precedence.

1.3. Document Responsibility

There is no obligation under the NER for *AEMO* to prepare this document. It is provided to assist MCs to develop asset management strategies that define alternative testing practices, other than time-based practices, as permitted under clause S7.6 of the NER for approval by AEMO.

2. LOW VOLTAGE CURRENT TRANSFORMER METERING INSTALLATIONS – SAMPLE TESTING

The following section outlines a sample testing process for low voltage *current transformer* (LV CT) *metering installations*.

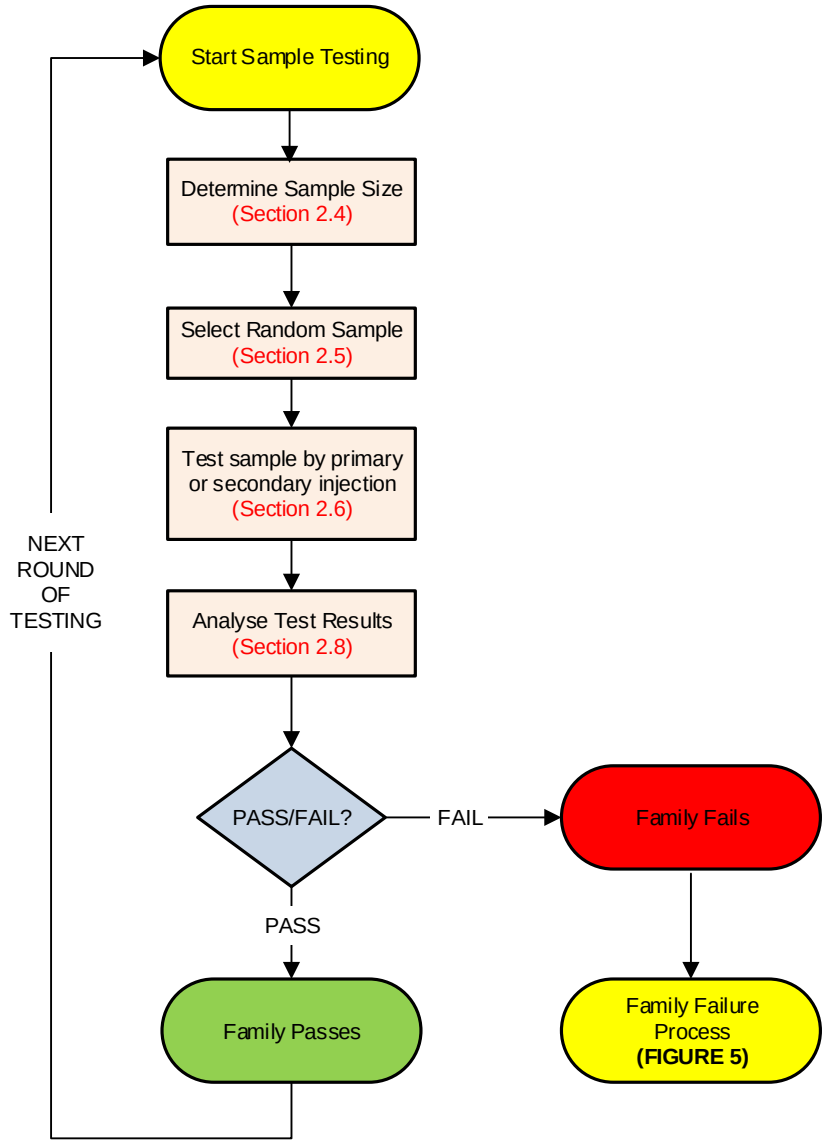
2.1. Eligible Metering Installations

All LV *CT metering installations* are eligible for sample testing provided an accompanying enhanced inspection, in accordance with section 4, is performed.

2.2. Sample Testing Flow Chart

The chart provided in Figure 1 presents an overview of the steps to be undertaken by an MC to determine the appropriate sample testing method, and the subsequent actions required to complete the sample testing process.

Figure 1 Sample Testing Process



2.3. Family Selection

Family populations are to be selected carefully before commencing sample testing.

Where applicable, the LV *CT*s must be homogeneous with respect to the following characteristics:

2.3.1. Family Characteristics

At a minimum, LV *CT*s must be broken down by design type. The common current transformer types are listed in the below table.

Table 1 Current Transformer Types

Type	Ratio
A	150 / 300 / 600 : 5
B	400 / 800 / 1200 : 5
C	1000 / 2000 / 3000 : 5
S	200 : 5
T	800 : 5
U	2000 : 5
V	4000 : 5
W	1500 : 5

2.3.2. Sub-Family Characteristics

The following are the sub-family characteristics which are to be considered for family population selection:

(a) Manufacturer (i.e. Email, Energy Controls, GEC, Nilsen, STEMAR, Warburton Franki)

(b) Date of manufacture (or year of install if unknown)

(c) Design standard of manufacturer (i.e. *AS* 1675, *AS* 60044.1)

(d) Model Class (i.e. class 0.5M, class 0.5S, class 0.5ME extended range)

(e) Geographical location

2.3.3. Example of Family Selection

The following is a simplified example to demonstrate how to select a family population for sample testing based on family and/or sub-family characteristics.

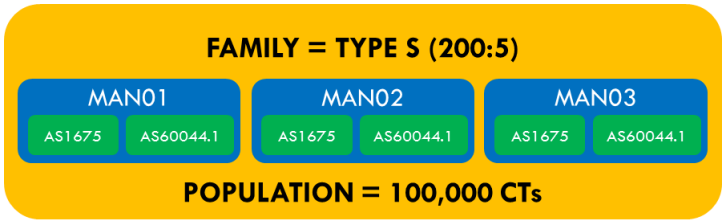
The extent a family is defined will depend on the general knowledge of a particular LV *CT* and balance between a more risk-averse approach, as it potentially means that a smaller population will fail, which results in a smaller family replacement.

For this example, there are three manufacturers (MAN01, MAN02 and MAN03) and two design standards (*AS* 1675 and *AS* 60044.1).

EXAMPLE 1 – Family Characteristics only

Under this example, only the *current transformer* type is used to define a family because there is no historical evidence to suggest that a sub-family characteristic may cause a family to fail.

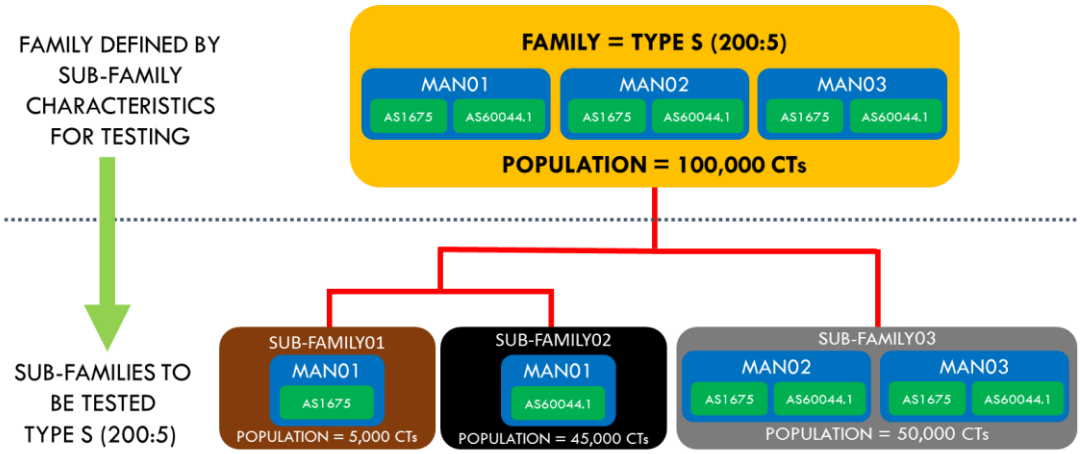
Figure 2 Example of Family selection based on Family Characteristics only



EXAMPLE 2 – Sub-Family Characteristics

Under this example, the *current transformer* type is further defined by the sub-characteristics to define the family because MAN01 has informed that their *current transformers* may not be performing as expected, so a more risk-averse approach is taken.

Figure 3 Example of Family selection based on Sub-Family Characteristics



2.3.4. Redefining a Family due to family failure

It may be possible to redefine a family, due to a family failure, into sub-families if there is sufficient supporting evidence that a sub-family characteristic is the cause of the original family failure.

The MC will need to prepare the supporting evidence and present it to AEMO as a family can only be redefined into sub-families with the approval of AEMO as per section 3.3.

When a family is redefined, the original sample's test results must be retained and aligned to the new sample size and acceptance number (Ac) required for the new redefined sub-families. The sample selection order must be preserved as the redefined family may require a smaller sample.

All redefined sub-families will need to be tested in accordance to their new family population size.

Once a family has been redefined, it cannot be combined again into another family.

Below are the possible actions that can be taken after a family has been redefined into sub-families. The number of failed test results from the original family compared to the redefined sub-families acceptance number (Ac), will determine the next course of action:

Table 2 Actions for redefined sub-families

Accept (Ac)	Action
Number of failed tests > (Ac)	FAIL FAMILY • Replace or 100% test as the number of failed test results already exceeds what is acceptable
Number of failed tests ≤ (Ac)	Test the redefined sub-families which will result in one of these two outcomes: • Number of failed tests > (Ac) = FAIL FAMILY • Number of failed tests ≤ (Ac) = PASS FAMILY (as approved by AEMO)

Using the family example provided in section 2.3.3 to come up with a typical testing scenario:

Round 1 Test = current transformer type (i.e. Type S - 200:5) = 100,000 CTs.

Following the completion of the first round of sample testing, the results find that the family has failed. The suspected cause of the failure appears to be related to a single manufacturer and potentially an older design standard but there is uncertainty.

The next step would be to liaise with AEMO to discuss the creation of potential sub-families based on the results found, to establish if a pattern can be identified.

Based on results, MAN01 is the suspected faulty sub-family and since it is uncertain whether design standards are a factor, there are two options when selecting sub-family groupings.

Round 2 Test = two options that can be taken.

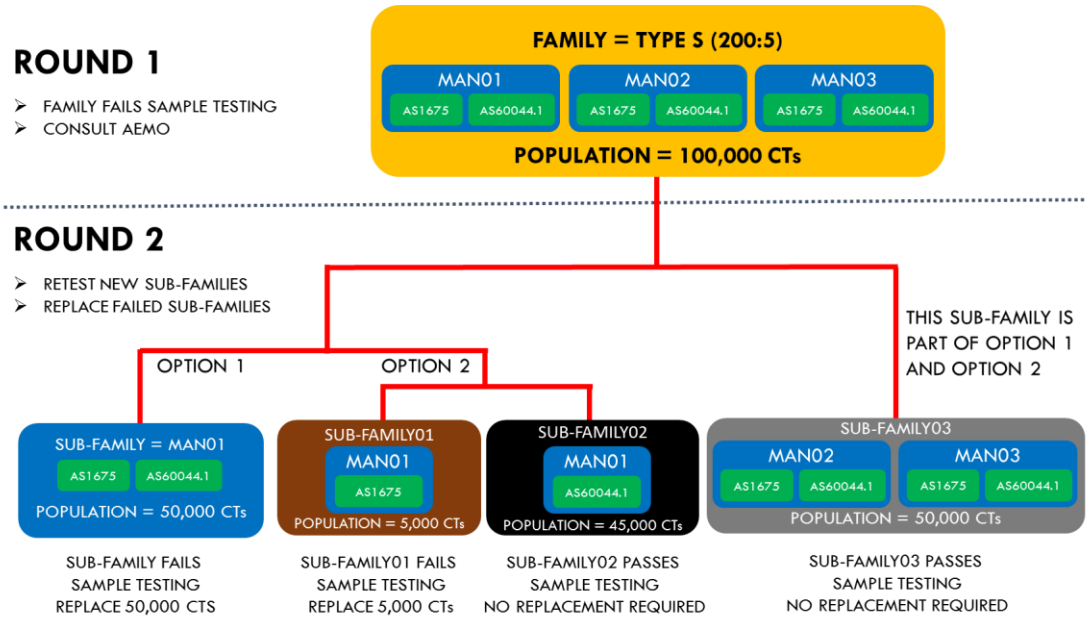
(a) Option 1 = MAN01 and MAN02 / MAN03

(b) Option 2 = MAN01 / *AS* 1675 and MAN01 / *AS* 60044.1 and MAN02 / MAN03

By choosing to retest the sub-family using the option 1 grouping, the whole population for the manufacture will need to be replaced if the sub-family fails.

By choosing to retest a sub-family using the option 2 groupings, there is an equal chance that the manufacturer will fail in one or both the design standards. Option 2, although it requires more testing, is the more risk-averse approach as it potentially means that a smaller population will fail, which results in a smaller family replacement.

Figure 4 Example of redefined Sub-Families



2.4. Sample Sizes based on Population Size

Sample testing approach chosen is based on *AS* 1199.1-2003 (p 19-20) using general inspection level II with the chosen AQL of 1.

Each MC must ensure the following steps are taken when determining their sample test plan:

(a) Determine the family size (must include previously sample tested LV *CTs*) based on *NMIs* or number of LV *CTs*. The family size must include all untested and already sample tested LV *CTs*.

(b) For a new family, begin testing using the normal inspection criteria (as defined in Table 3 below).

(c) For an existing family:

(i) If the sample test plan passes (as per section 3.1) and the number of non-conforming items is 0 at a normal inspection criteria (as defined in Table 3 below), continue to test using the normal inspection criteria for the next test cycle.

(ii) If the sample test plan passes (as per section 3.1) and the number of non-conforming items is greater than 0 at a normal inspection criteria, switch to a tightened inspection criteria (as defined in Table 4 below) for the next two consecutive test cycles. If the next two consecutive test cycles pass, then on the third test cycle switch back to a normal inspection criteria.

Table 3 Sample Sizes and Acceptance and Reject Levels (Normal Inspection GLI-II)

Family Size		AQL = 1.0		
Min	Max	Sample Size (*n*)	Accept (Ac)	Reject (Re)
1	13	ALL	N/A	N/A
14	150	13	0	1
151	500	50	1	2
501	1200	80	2	3
1201	3200	125	3	4
3201	10000	200	5	6
10001	35000	315	7	8
35001	150000	500	10	11

Table 4 Sample Sizes and Acceptance and Reject Levels (Tightened Inspection GLI-II)

Family Size		AQL = 1.0		
Min	Max	Sample Size (*n*)	Accept (Ac)	Reject (Re)
1	20	ALL	N/A	N/A
21	150	20	0	1
151	1200	80	1	2
1201	3200	125	2	3
3201	10000	200	3	4
10001	35000	315	5	6
35001	150000	500	8	9

* Sample Size and Acceptance and Rejection Levels tables are based on AS 1199.1

2.5. Sample Selection

2.5.1. Randomisation

The sample from each family must be drawn at random as outlined in section 2.5.3, without replacement (i.e. each site chosen as part of the sample will be excluded from the next round of sample testing), until the population is exhausted.

Random selection is where a sample (s) is taken from a population (p) in such a way that each item of interest has an equal probability of being chosen from population (p).

Where the family size is based on *NMI*s, if a *NMI* is for a *metering installation* that has a number of LV CTs from different families, that *NMI* will be eligible for selection for each family that is installed at that *metering installation*.

2.5.2. Sample Size

Selected sample size is to be in accordance with the minimum required sample size n + 100% for the population (p) as outlined in section 2.4.

An additional 100% is chosen to cater for situations where reasonable endeavours have failed to facilitate the necessary in-situ testing, such as 'isolation not possible', 'installation decommissioned', or 'physical damage to the LV *CT*'.

2.5.3. Randomisation Method

The method for random selection is as follows:

(a) All *NMI*s from the same family to be assigned number 1 to population (p).

(b) Using a random number generator, generate numbers at random between 1 and population (p), until sample size (n) + 100% is reached (or population (p) where sample size (n) is > 50% of population (p)).

(c) The sample of size (n) will be determined by the sequential order of the assigned number against each item of interest.

(d) If a LV *CT* was tested in the previous round of sample testing, it is to be skipped for the current round of sample testing and the next item of interest in the sequence is to be selected for testing. (Note: the LV *CT* that was skipped is eligible for random selection in the following round).

(e) If population is based on number of LV *CT*s, then randomly pick one LV *CT* from the total number installed at a *metering installation* (nominally three) to form part of the sample testing analysis (Note: all installed LV *CTs* at the *metering installation* require testing, but only the result of the test for the LV *CT* selected will be used when analysing results for sample testing).

2.6. Test Points and Test Burden

To accommodate a cohesive sample testing regime, testing of LV *CTs* must be done by either primary and/or secondary injection testing in-situ to the limits of error outlined at 25% of rated burden resistive - unity power factor (i.e. power factor = 1.0).

Table 5 Limits of Error

% Rated Current	Current Error Limits	Phase Displacement Limits (Minutes)	Phase Displacement Limits (crad)
5	± 1.5	± 90	± 2.7
20	± 0.75	± 45	± 1.35
100	± 0.5	± 30	± 0.9
Extended Range	± 0.5	± 30	± 0.9

* Limits of Errors are based on AS 60044.1

LV *CTs* must be demagnetised before the commencement of testing. LV *CTs* may be tested before demagnitisation; however, the results can only be used to investigate effects of magnetisation and will not be considered part of the sample testing analysis by *AEMO*.

2.7. Multi-tap LV CTs

Multi-tap LV *CT*s must have all tap ratios tested for the limits of error outlined in section 2.6.

2.8. Test Result Analysis

A test item is deemed to have passed accuracy if the test results are within the limits of error outlined in section 2.6.

A test item is deemed to have failed accuracy if the test results are outside the limits of error outlined in section 2.6

Where the MC has elected to define the family size by the *NMI*, then all failed test results for that *NMI* will count as one failure towards family acceptance.

Where the MC has elected to define the family size by the number of LV *CT*s, then only the failed test result for the randomly selected LV *CT* will count as a failure towards family acceptance criteria.

2.9. Testing Frequency

2.9.1. Initial Life for a new LV CT

The initial life for a new LV *CT* is 10 years from the last test date as recorded on an endorsed test report, which is covered by a NATA ISO/IEC 17025 accreditation or another accreditation body which is a signatory of the International Laboratory Cooperation Mutual Recognition Arrangement (ILAC MRA) or primary injection test results tested using calibrated test equipment performed by an accredited MP.

At the end of the initial life, that LV *CT* is eligible for sample testing. These LV *CT*s can either form a new family or be incorporated into an existing one provided there is homogeneous characteristics that will allow for it.

2.9.2. Ongoing testing

Sample testing will be required to be undertaken on a 5 yearly rolling test cycle. This will ensure that testing resources can be scheduled across the NEM more efficiently.

Should a family or sub-family during the 5 yearly rolling test cycle show early indicators that it is likely to fail (or has failed), *AEMO* must be notified promptly to assess what further action will need to be taken for that family or sub-family prior the current test cycle ending.

2.9.3. Example of incorporating new LV CTs into an existing family

Using the family example provided in section 2.3.3 to demonstrate what would happen:

FAMILY01 = current transformer type (i.e. Type S - 200:5) = 100,000 LV *CT*s and is due for sample testing in 2020.

In 2020, the MC has also installed 1,000 brand new Type S LV *CT*s. As per the NER, these are not due for testing for 10 years, until 2030.

Test Cycle 1 (2020) – FAMILY01 = 100,000 = passed

Test Cycle 2 (2025) – FAMILY01 = 100,000 = passed

Test Cycle 3 (2030) – FAMILY01 = 101,000 as the new LV *CT*s installed in 2020 are now due for testing and have been incorporated into the family.

2.10. Overall Error Accuracy Requirements

Provided that the LV *CT* family or sub-family as a sample pass testing the requirements of this guideline and the associated *meters* meet the accuracy and testing requirements of the NER (including an *AEMO* approved asset management strategy that defines an alternative testing practice other than time-based testing), then the *metering installations* with LV *CT*s in the family of LV *CT*s that have passed sample testing are deemed to meet the overall error requirements of the NER.

3. RULES FOR ACCEPTANCE AND NON-ACCEPTANCE

3.1. Acceptance

A family or sub-family is accepted if the number of non-conforming items found during sample testing is equal to or less than the acceptance number (Ac).

3.2. Nonconforming Items

Notwithstanding family or sub-family acceptance, any non-conforming items found during testing, whether part of sample or not, must be replaced with a like for like. If no like for like can be found, all items must be replaced.

Non-conforming items must be analysed to check for possible sub-family characteristic failures. The reasons that the non-conforming item failed the accuracy test are to be determined through analysis, the results of which are to be recorded.

3.3. Non-Acceptance and Resubmission

For sample testing, a family or sub-family is deemed unacceptable and a failure if the number of non-conforming items found during sample testing is greater than the acceptance number (Ac).

In the event of a family or sub-family failure, the consequences of which are family or sub-family replacement, the MC must consult with AEMO to develop a strategy, including the timeframe, for the rectification of the family non-compliance. The strategy, including the timeframe, for the rectification of the family non-compliance, is subject to approval of AEMO.

AEMO, in assessing the proposed strategy, will consider a:

(a) Retest of a sub-family, provided that sub-family characteristics have been identified and are the cause of the family failure.

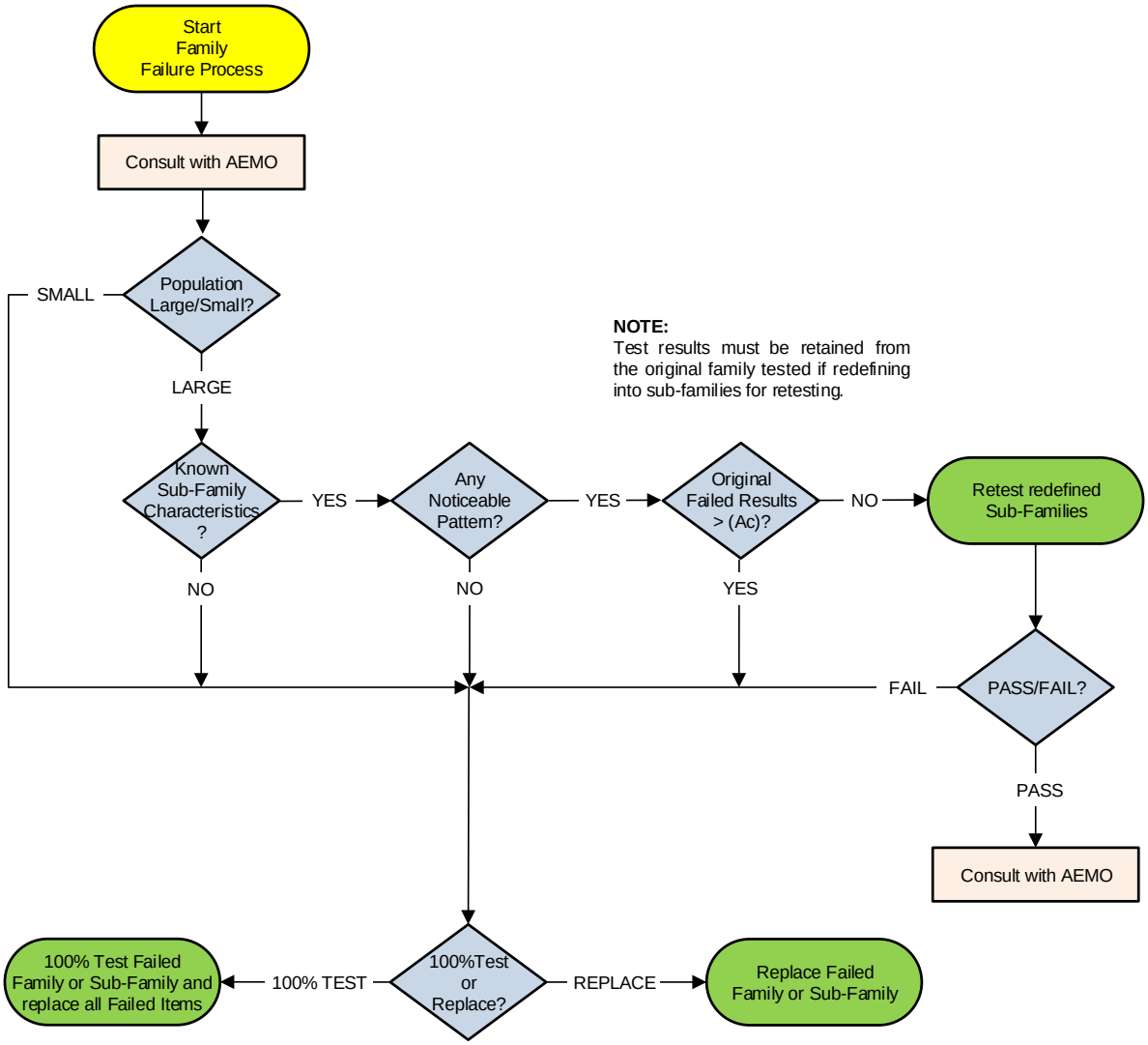
(b) 100% retest of the family and replace all failed items.

(c) Full family replacement.

3.4. Family and Sub-Family Failure Process

The following is the process *AEMO* will follow in determining the appropriate course of action in the event of a family or sub-family failure.

Figure 5 Family and Sub-Family Failure Process



4. ENHANCED INSPECTION PROGRAM

4.1. Inspection Methodology

To support a regime of demonstrated compliance of *metering installations* through sample testing, an enhanced inspection program of the *metering installations* must be incorporated as part of the alternative testing practice The following inspection program items must be carried out as a minimum:

4.2. Inspection Frequency

All LV *CT metering installations* must be inspected at a period no greater than 5 years on an ongoing cycle basis.

4.3. Minimum Testing and Inspection Requirements

The following are the minimum testing and inspection requirements:

(a) Admittance test (preferred) or undertake primary/secondary ratio check (if safe to do so).

(b) Measure connected burden.

(c) Compare the secondary current value at LV *CT* test block against meter register.

(d) Position and tightness of LV *CT* metering links.

(e) Check for corrosion, damage and atrophy.

(f) Condition of the wires, terminals and potentials fuses.

(g) Correct polarity of all voltage and current connections and phase relationships.

(h) Correct applied phase rotation (for Ferraris disc meters).

(i) Correct applied ratio to meter for connected LV *CT* ratio.

4.4. Information Gathering and Reverification

To allow for more sub-family characteristics to be considered when selecting family populations for sample testing, the following information must be gathered or reverified as part of the enhanced inspection:

(a) Installation date.

(b) Design standard of manufacture.

(c) Connected ratio.

(d) Available ratios and LV *CT* type/form.

(e) Class accuracy.

(f) Rated burden.

(g) Manufacturer.

(h) Encapsulated or exposed.

(i) Serial number.

Additional comments where *metering installations* are subjected to non-standard installations and environments should be recorded as this may assist in sub-family analysis.

4.5. Unknown Assets

In situations where an inspection is unable to ascertain details that would allow the LV *CTs* to be classified into a family as outlined in section 3.3, those LV *CTs* must at a minimum be either:

(a) Accuracy tested for compliance to the test points and burden as per Table 5; or

(b) Replaced with a new set of LV *CTs*.

4.6. Isolated Failures

All assets which are found to have failed or to be non-compliant, including those found as a result of activities outside the alternative testing practice, must be analysed further to determine the cause of the non-compliance.

All information about the particular non-compliance must be recorded and stored for review for future family grouping considerations. These records of random failures may assist in identifying potential failure patterns across the *NEM*.

4.7. Meter Testing at LV CT *metering installations*

As part of the enhanced inspection, for risk mitigation purposes, all type 3 and any type 4 *meters* installed at LV *CT metering installations* that have a *NMI* with a classification of 'Large' in MSATS are to be tested for accuracy.