The SANAS Accreditation Requirements to Participate in the 12L Tax Allowance Measurement and Verification (M&V)

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SABS TC 301 – Energy Management (Convener for SABS WG’s 5 & 8)
Who is the South African National Accreditation System?

SANAS is South Africa’s sole national accreditation body that provides an internationally recognised and effective accreditation system in respect of conformity assessment, calibration and monitoring of good laboratory practice (GLP).

Why SANAS?

SANAS accreditation is a formal process of assessing and recognising whether a M&V Inspection Body is technically competent to carry out specific M&V tasks as stated on the schedule of accreditation issued by SANAS.
In Other Words
Accredited M&V Inspection bodies use the reports issued, with the SANAS Logo, to prove that their work comply with the SANS 50 010 M&V Standards and the compulsory 12L regulations and in doing so providing comfort to stakeholders that the reported savings has occurred.

IN SHORT:
No doubt exist that the claimed 12L savings is real!

“You are what you do, not what you say you’ll do.”
- Carl Jung
Accreditation process
Accreditation process (cont...)

**Overly Simplified Version:**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Applicant request information pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td>Provide the necessary documentation to SANAS</td>
</tr>
<tr>
<td>Step 3</td>
<td>If complete, SANAS issue a quote</td>
</tr>
<tr>
<td>Step 4</td>
<td>Applicant accepted/paid</td>
</tr>
<tr>
<td>Step 5</td>
<td>Documentation is reviewed</td>
</tr>
<tr>
<td>Step 6</td>
<td>If satisfactory an on-site Assessments is performed</td>
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<tr>
<td>Step 7</td>
<td>If no serious Non-Conformances are found on the day the body is accredited (on condition that the SANAS Committee approves)</td>
</tr>
<tr>
<td>Step 8</td>
<td>Surveillance- and Re- Assessments at regular intervals</td>
</tr>
</tbody>
</table>
To be purchased:

- ISO 17 020 – Conformity Assessment…
- SANS 50 010 – M&V Standard…

Available from SANAS Website (free):

- F 14IB – Application for Inspection…
- TR 81 – Technical Requirements for Application…
- TR 25 – Traceability
- F 139 – Generic Checklist…(*Lead-Assessor*)
- F 82 – Vertical Assessment…(*Technical Assessor*)
- F15 – Witnessing of Activity…(*Typically Technical Assessor*)
- F 03 – Non-Conformances & Corrective Actions (*Both*)
1. Go to http://home.sanas.co.za/?page_id=38
2. Click on Inspection bodies
3. Type “Measurement and Verification” in the Compliance block
4. Click on Search
5. The Accredited bodies will appear below
6. Click on the Facility No for more details
SABS:SANS 50 010
Measurement and Verification (M&V)
Overview
Overview of Presentation

- Clarity on Some Terminology
- M&V Approach
- Boundary for measurement
- Measurement periods
- Calculation of the baseline
- Basis for baseline adjustments
- Measurement of Variables
- Uncertainty
- Some Questions & Answers addressed
Clarity on some Terminology

Some terms being used without considering differences:

- Measurement and Verification (M&V)
- Monitoring and Verification (“M&V”)
- Monitoring and Targeting (M&T)
- Monitoring and Evaluation (M&E)
- Measurement, Reporting and Verification (MRV) – CDM process
Introduction - SANS 50010

• SANS 50010 is intended to provide a **standard approach** and an **assurance** that actual savings would **always be more than or equal** to the reported savings (conservative results).

• The methodology described in this document has been **successfully used** (in South Africa as well as internationally) to determine energy and demand savings.

“Energy savings cannot be directly measured, since savings represents the absence of energy use.”
“The process of quantifying EE savings or the impacts by determination of **actual consumption** and **relevant energy-governing factors**, and to develop **baselines and baseline adjustments**” [SANS 50010 (definition 3.14)]
4.1.3 M&V Approach

SANS Definition: Energy-efficiency savings

“Difference between the actual amount of energy used in the carrying out of any activity in a specific period and the amount of energy that would have been used in the carrying out of the same activity during the same period under the same conditions if the energy-savings measure was not implemented” [SANS 50010 (definition 3.6)]

Exactly the same as defined in the Section 12L Regulations!!
4.1.3 M&V Approach

SANS Definition: Baseline

“The energy use representing conditions before the implementation of the energy-savings measures under a set of known energy-governing factors or relationships applicable at the time of the baseline measurement period to the activity in question, (or both)”.

Section 12L Regulations Definition: “baseline as defined in the standard”!!
4.1.3 M&V Approach

Dec / Jan Closures for Holiday (Low energy use)

Energy Use

- Normal Usage
- Expected future usage
4.1.3 M&V Approach

![Graph showing energy use from June 2012 to June 2015. The graph includes three lines:
- Blue line: Normal Usage
- Red line: Expected future usage
- Green line: Expected Usage after EE retrofit

The graph illustrates the energy use trends over the specified period, with notable drops and increases at certain intervals.]
4.1.3 M&V Approach

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage

Energy Use

Jun-12 to Jun-15
4.1.3 M&V Approach

Energy Use

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage

Huge Order! Will have to work through Dec / Jan (2x Shifts)
4.1.3 M&V Approach

Huge Order! Will have to work through Dec / Jan (2x Shifts)
4.1.3 M&V Approach

Energy Use

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage

Huge Order!
Will have to work through Dec / Jan (2x Shifts)
4.1.3 M&V Approach

![Graph showing energy use over time with different usage scenarios: Normal Usage, Expected future usage, Expected Usage after EE retrofit, and Actual usage. The graph highlights changes in energy use from June 2012 to June 2015.]
4.1.3 M&V Approach

Energy Use

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage

Negative Savings?
4.1.3 M&V Approach

**SANS / 12L Definition for EE Savings:** “Difference between the actual amount of energy used in the carrying out of any activity in a specific period and the amount of energy that would have been used in the carrying out of the same activity during the same period under the same conditions if the energy-savings measure was not implemented” [SANS 50010 (definition 3.6)]

**Negative Savings?**

NO!

Consider:

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage
4.1.3 M&V Approach

**SANS / 12L Definition for Baseline:** “The energy use representing conditions before the implementation of the energy-savings measures under a set of known energy-governing factors or relationships applicable at the time of the baseline measurement period to the activity in question, (or both).”
4.1.3 M&V Approach

Energy Use

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage
- M&V after implementation

Do SANS M&V!

Normally Slightly less Savings?
4.1.3 M&V Approach

Adjust Baseline (To would have happened condition!)
4.1.3 M&V Approach

- Normal Usage
- Expected future usage
- Expected Usage after EE retrofit
- Actual usage
- M&V after implementation

Positive Savings!
### 4.1.3 M&V Approach

#### Like-for-like comparison of actual vs adjusted baseline energy use:

1. Situation without adjustments …

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>?</td>
</tr>
</tbody>
</table>

   What's happened? On first inspection, it appears that both demand and usage have increased.

2. An energy model is developed to ‘explain’ and adjust baseline use …

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Adjusted Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENERGY MODEL</td>
</tr>
<tr>
<td></td>
<td>Increased operating hours</td>
</tr>
<tr>
<td></td>
<td>Higher occupancy</td>
</tr>
</tbody>
</table>

   By analysing independent energy governing factors it is clear that other factors have changed. An energy model is developed to adjust for site changes.

3. The ‘adjusted baseline’ to enable like-for-like comparison …

<table>
<thead>
<tr>
<th>Adjusted Baseline</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like-for-like</td>
<td></td>
</tr>
</tbody>
</table>

   A like-for-like comparison can now be made …

   … and the difference is the savings.
4.1.3 M&V Approach

ESM Project Stages
- PROJECT IDENTIFICATION
- ENERGY AUDIT & ASSUMPTIONS
- RECOMMENDATIONS FOR IMPLEMENTATION
- APPROVAL FOR FUNDING
- DETAIL DESIGN
- IMPLEMENTATION
- COMMISSIONING
- OPERATION & MAINTENANCE

M&V Stages
- SCOPING
- M&V PLAN
- M&V BASELINE
- POST-IMPLEMENTATION ASSESSMENT
- PERFORMANCE ASSESSMENT: BASELINE ADJUSTMENTS AND ANNUAL SAVINGS REPORT

Did you get BUY-IN?
- Yes
- No

Refine M&V Plan
- Refine M&V Baseline

STEP 1: SUBMIT COMBINED Report TO SANEDI
STEP 2: SUBMIT COMBINED Report TO SANEDI

Did you get BUY-IN?
4.1.3 M&V Approach

The effect of an Energy Savings Measure is best understood against the energy usage that would have occurred in a ‘business as usual’ situation had the ECM not been implemented. SANS 50010 (definition 3.6)
4.1.3 M&V Approach

**SAVINGS** = 'Adjusted Baseline' minus 'Actual'

**Actual Baseline:** Monthly energy usage

**Baseline Model:** Energy model developed using baseline usage and activity data

**Actual Post-Retrofit:** Monthly energy usage

**Adjusted Baseline:** 'Business as Usual' forecast of usage using current activity data
## 4.2 Boundary for Measurements

<table>
<thead>
<tr>
<th>SABS:SANS 50 010 Protocols</th>
<th>Savings Calculation</th>
<th>Typical Application</th>
</tr>
</thead>
</table>
| **Option 1a: Retrofit Isolation Key Parameter Measurements**  
Savings determined by partial short-term or continuous field measurement of energy use separate from facility energy use. | Engineering calculations using short term measurements or stipulations. | Boiler pre- and post- retrofit efficiencies are measured and operating hours are stipulated based on interviews or logs. |
| **Option 1b: Retrofit Isolation All Parameter Measurements**  
Savings determined by short-term or continuous field measurement of energy use of applicable systems, separate from energy use of the rest of the facility. | Engineering calculations using short- term or continuous measurements. No stipulations or assumptions. | Air conditioning pre- and post- retrofit energy use is determined by short-term or continuous measurements of applicable systems. |
| **Option 2: Whole Facility**  
Savings determined by measuring energy use at whole facility level. Short- term or continuous measurements are taken during the post- retrofit period. | Regression analysis of whole facility meters or sub- metering data. | Energy management system savings based on regression analysis of utility billing data for pre- retrofit billing data and post- retrofit energy use is based on calibrated simulation. |
| **Option 3: Calibrated Simulation**  
Savings determined through simulation of energy use components or whole facility and calibrated to pre- or post- retrofit utility billing data. | Energy use simulation, calibrated with monthly utility billing data. | Weather- sensitive measures with pre- and post- |
4.2 Boundary for Measurements

More than 1 project on single site in the same reporting period?

Resolving double counting issues through ordered summation of remainders

Use Protocol which would allow for summation:
1. Option 2: Whole Facility
2. Option 3: Calibrated Simulation

OR
4.2 Boundary for Measurements

More than 1 project on single site in the same reporting period?
Resolving double counting issues through ordered summation of remainders

Use Option 1a or 1b

- ESM #1 savings are claimed in full (i.e. claims all overlaps).
- ESM #2 savings are reduced by the influence of ESM #1.
- ESM #3 savings are reduced by the influence of both ESMs #1 and #2.
4.2 Boundary for Measurements

HVAC System Diagram:

Energy governing factors:
- Occupancy / Internal Heat Loads
- Operating Hours
- Ambient Temperature

Electrical Energy (Input)

Building Cooling Load

Cooling Towers
- CT 1
- CT 2

Condenser Water Pumps
- CWP 1
- CWP 2

Chillers
- Chiller 1
- Chiller 2
- Chiller 3

Chilled Water Pumps
- ChWP 1
- ChWP 2

Condenser Water Loop
(Heat energy rejected)

Chilled Water Loop
(cooling energy delivered)
4.2 Boundary for Measurements

Chiller 2 is replaced

Energy governing factors:
- Occupancy / Internal Heat Loads
- Operating Hours
- Ambient Temperature

Electrical Energy (Input)

Building Cooling Load

Chiller 1
Chiller 2
Chiller 3

Chiller 1
CT 1 CWP 1

CT 2
CWP 2

Chiller 2

Chiller 3
ChWP 1
ChWP 2

Condenser Water Loop
(Heat energy rejected)

Chilled Water Loop
(cooling energy delivered)
4.2 Boundary for Measurements

Chiller 2 is replaced

NOTE: Consider Interactive-Effects
4.2 Boundary for Measurements

Chiller 2 is replaced

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4.2 Boundary for Measurements

Chiller 2 is replaced

Energy governing factors:
- Occupancy / Internal Heat Loads
- Operating Hours
- Ambient Temperature

NOTE: Consider Interactive-Effects
4.2 Boundary for Measurements

Considerations when measuring, collecting and processing baseline data (which also applies to post retrofit measurements) include:

• Key parameters to measure (e.g. energy consumption, power draw, temperature)
• Measurement approach (e.g. continuous, periodic, sampling, once-off)
• Measurement equipment and placement (e.g. data loggers, utility meter, sensors, flow meters, pressure meters, etc.)
• Measurement interval (e.g. 1 month, 1 week, 1 day, 1 hour, etc.)
• Measurement start/finish dates
• Measurement duration (e.g. instantaneous readings, 2 weeks, 1 month, 12 months)
• Data collection, processing and integrity (e.g. software, format, completeness)
• Calculating uncertainty (e.g. measurement equipment, sampling, standard errors, etc.)

Remember to always consider Data measurement and collection principles, and Uncertainty!
4.2 Boundary for Measurements
4.2 Boundary for Measurements

Baseline based on Pre-Implementation Model
Post-Implementation (Actual)
Impact

Total Load (Pre) [kW]  Total Load (Post) [kW]  Overall Impact [kW]
4.3 Measurement Periods

4.3.1 **Baseline** measurement period

- Fairly represent all operating modes & conditions of operating cycles (or normal operating cycle) of the facility.
- Include only time periods for which all fixed and variable energy-governing factors are known about the facility.
- Coincide with the period immediately before implementation of the energy savings measure to provide a proper baseline for measuring the effect of just the energy savings measure.
4.3 Measurement Periods (cont…)

4.3.2 **Reporting** measurement period

- The reporting measurement period **shall have at least one normal operating cycle of the equipment or facility**, in order to fully characterize the savings effectiveness in all normal operating modes.
- The **length of any reporting period** shall be determined with due consideration of **the life of the ESM** and the likelihood of degradation of originally achieved savings over time.
- The reporting measurement period may also depend on legislative or **other compliance requirements** (or both), **the period for which energy may be claimed** – **12 months for S12L**
4.1 Calculation of the Baseline

4.1.1

Energy savings shall be determined by comparing measured use before and after implementation of a project and making suitable adjustments for changes in conditions (“energy governing factors”).

– NOTE: Energy savings cannot be directly measured, since savings represent the absence of energy use.
4.4 Basis for Baseline Adjustments

4.4.2 **Routine adjustments:** - where energy-governing factors changes routinely, e.g. weather/production conditions. **Appropriate techniques** may include constant value to parameter non-linear equations correlating to the energy governing factors

4.4.3 **Non-routine adjustments:** provides for changes in facility size, changes in shifts, changes in occupation, etc.
6 Measurement of Variables

6.1.2 Determination of energy shall be either by the direct measurement of energy flow or by the direct measurement of proxies of energy use that give the direct indication of energy use. The energy quantities in the several forms of the energy savings equation shall be measured by one or more of the following techniques:

a) energy supplier invoices, and/or measuring equipment;

b) special meters that isolate an ESM to a system or portion of a system or facility from the rest of the system or facility;

c) measurements shall be either periodic for short intervals, or continuous throughout the baseline or reporting periods;

**Variables = Energy-governing factors**
6 Measurement of Variables

Does a relationship exist between the energy governing factor(s) and energy use?

FYI: Variables = Energy-governing factors
7 Uncertainty

7 Uncertainty shall be managed to ensure that reported savings are likely to be conservative.

Exact quantification of uncertainty is not required, however; uncertainty shall be taken into account such that more accurate measurements or a more rigorous M&V process cannot invalidate the result.

In this context, invalidating a result means that LOWER savings are reported.

Management of uncertainty shall include
- Any values, weather measured or estimated
- The baseline period energy use,
- The reporting period energy use
- The choice of methodology
- Energy governing factors
- Estimation of interactive effects

3600kJ = 1kWh
What is measurement **Uncertainty**?

- **Sampling**
  - Sample size, meter distribution
- **Measurement equipment**
  - Equipment calibration
- **Modelling**
  - Regression, $R^2$, Histograms, Standard Deviation, Coefficient of Variation, Standard Error, $t$-statistic, Max & Min Values, Precision, Confidence, # digits, etc..
- **Other uncertainties** such as human, etc., is unquantifiable.
7 Uncertainty

The usual Approach to **Uncertainty**:

- **Precision** is an assessment of the error margin of the final estimate.
- **Confidence** is the likelihood that the metering target will fall within the *precision* range.
- Example
  - Statistical statement: “the best estimate of savings is 2000 kWh annually with 90% (confidence) that true mean value falls within ±7.5% (precision) of 2000”.

**Poor precision**: Achieved savings are 100 000kWh ±100% with 90% confidence

**Low confidence**: Achieved savings are 100 000kWh ±7% with 10% confidence
7 Uncertainty

Increasing Precision

Increasing Confidence

Decreasing Uncertainty

Error

Bias
Balancing precision and confidence

Relatively HIGH CONFIDENCE but relatively LOW PRECISION:

90% confident that the true average savings falls between a precision range of 8,400 to 11,600
7 Uncertainty

Balancing precision and confidence

Relatively **HIGH PRECISION** but relatively **LOW CONFIDENCE**:

10% confident that the true average savings falls between a precision range of 9,700 to 10,300
7 Uncertainty

Regression Analysis

Correctness of Fit ($R^2$)

Energy Model ($y$)

$kW$ VS Flow

Energy Model ($y$): $y = 0.0524x + 646.71$, $R^2 = 0.5006$

$kW$ VS Flow

Energy Model ($y$): $y = 0.0136x^2 - 0.6075x + 10.536$, $R^2 = 0.2501$
Where uncertainty is unacceptable, consider taking the following actions:

- Use more precise measurement equipment
- Look for more independent energy governing factors that have an influence on energy consumption
- Increase the measurement sample size
- Review the measurement boundary to minimise unknowns
- Use an alternative M&V option that is less affected by unknown variables
6.4 The following documentation shall be made available on request during an inspection:

a) the **scope** of the ESM;
b) the **data** used to construct the **baseline**;
c) **measurement points and equipment** used;
d) the **methodology** used;
e) the **equation(s) applied**; and
f) **reported savings**
WHO WILL ULTIMATELY BE BLAMED FOR ENERGY EFFICIENCY SAVINGS BEING REPORTED INCORRECTLY?

The M&V Professional (SANAS Technical Signatory), employed by the SANAS accredited M&V body, is ultimately accountable for the Energy Efficiency Savings being reported!

RATHER BE SAFE THAN SORRY!!!
THANK - YOU