

# Accelerated Reliability Testing of kWh-meters

## Information-sheet about KEMA services testing and certification

There are several ways to evaluate the reliability of an energy meter. You might know that IEC provides a series of standards related to reliability / dependability testing or evaluation. These standards are:

- IEC 62059-11 -general concepts
- IEC 62059-21 -collection of meter dependability data from the field
- IEC 62059-31-1 -accelerated reliability testing
- IEC 62059-41 -reliability prediction

This sheet will give you some information of IEC 62059-31-1.

### **IEC 62059-31-1**

In many countries all over the world, large-scale replacements of installed base kWh-meters are taking place. In most of these locations, the majority of the installed base are electromechanical meters, with proven long standing technology. Smart metering projects, requiring additional functionality, will result in large-scale replacements with electronic meters. Because of this, financial risks will increase, as replacements will expect to be undertaken in large-scale accelerated projects, rather than over longer-term, life-cycle substitutions. Utilities require certainty on the expected lifetime of new meters and are requiring meter manufacturers to independently test and certify the reliability of these meters.

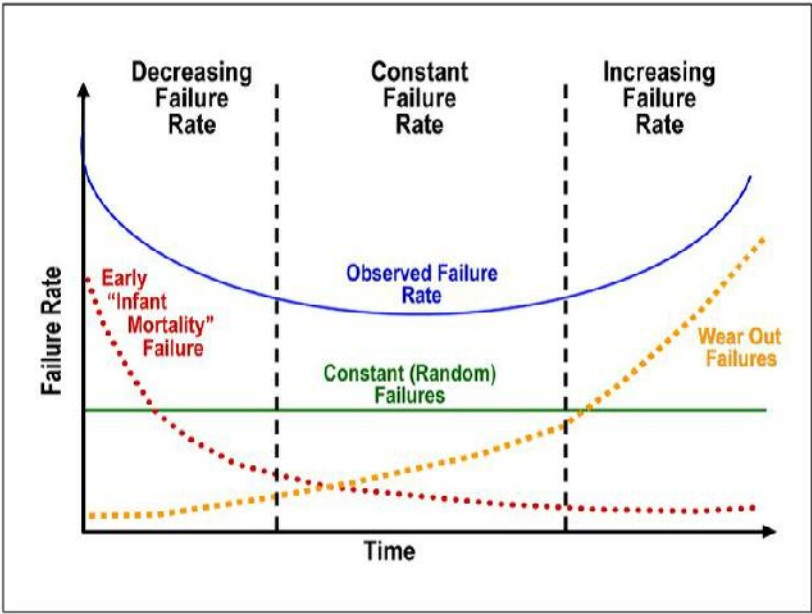
To support the utilities need for increased metering reliability, KEMA is developing the service: Assessment of the substantiated claims by manufacturers for expected lifetime of their meters, according to IEC 62059-31-1.

**OBJECTIVES**

In 2008, the new Standard for accelerated reliability testing of energy meters (the IEC 62059-31-1) is published.

The objective of this Standard is to provide a standard tool for manufacturers to substantiate their claims for expected lifetime. Additionally, this method will be very useful in the validation of these designs and to control design changes.

Semiconductor (as in static meters) reliability is typically depicted with the so called “bathtub curve”, as illustrated in figure 1. This curve shows the failure rate of products with respect to time and is made up of three individual curves related to infant mortality, useful life, and wear-out. Each region is characterized separately with potential failures classified as early/quality failures, random failures and wear-out failures, respectively. The ideal shape to the curve is to have a very long useful life period and a low amount of quality defects.



*Figure 1: "Bathtub Curve" effect*

The objective of reliability stress testing is to evaluate how the product will perform when used in machines, systems or the environment for which it is manufactured. Various models exist to extrapolate the accelerated test conditions to useful lifetime predictions.

The pre-condition of using the method is the availability of an appropriate life-stress model for the failure modes of interest. For stress influences, various parameters are applicable in general for electronic equipment, as shown in figure 2.

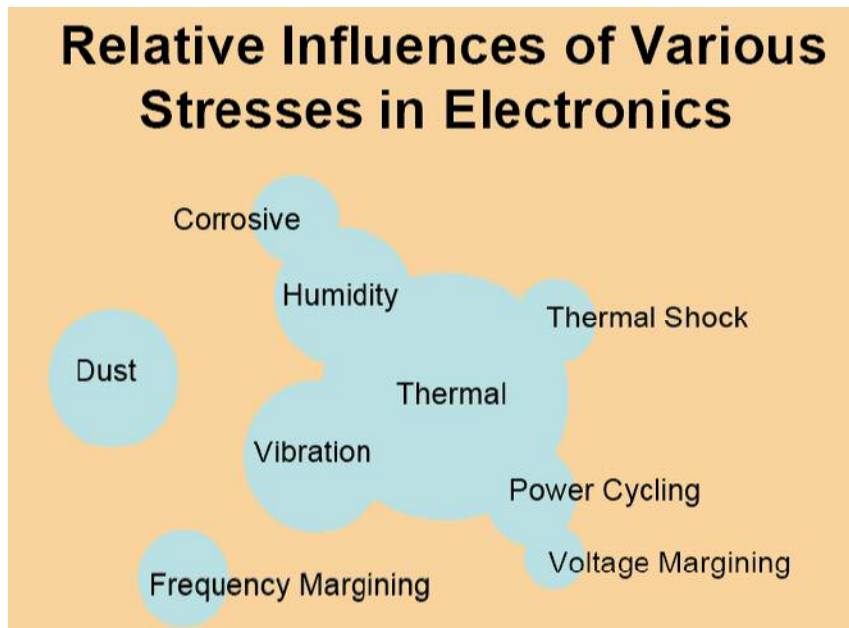


Figure 2: Relative Influences of Various Stresses in Electronics

***For static indoor energy-meters, thermal and humidity stresses are the two most significant parameters.***

The model described in the IEC Standard is, that the time-to-failure for each failure modes of the meter under test has to be established at five combinations of elevated temperature and humidity.

From these data, the life distribution at elevated temperature and humidity and the acceleration factors for each failure mode can be determined and the life distribution of the meter at normal use conditions, taking into account all observed failure modes, can be calculated, with a given confidence limit.

As the underlying distribution is Weibull, wear-out failures are also accommodated.

One characteristic feature of the test is that it takes longer to test a good meter than a bad one! However, there are also rules to determine when the test can be stopped. Therefore, even perfect meters do not have to be tested in perpetuity.

### TEST METHOD AND EVALUATION OF TEST RESULTS

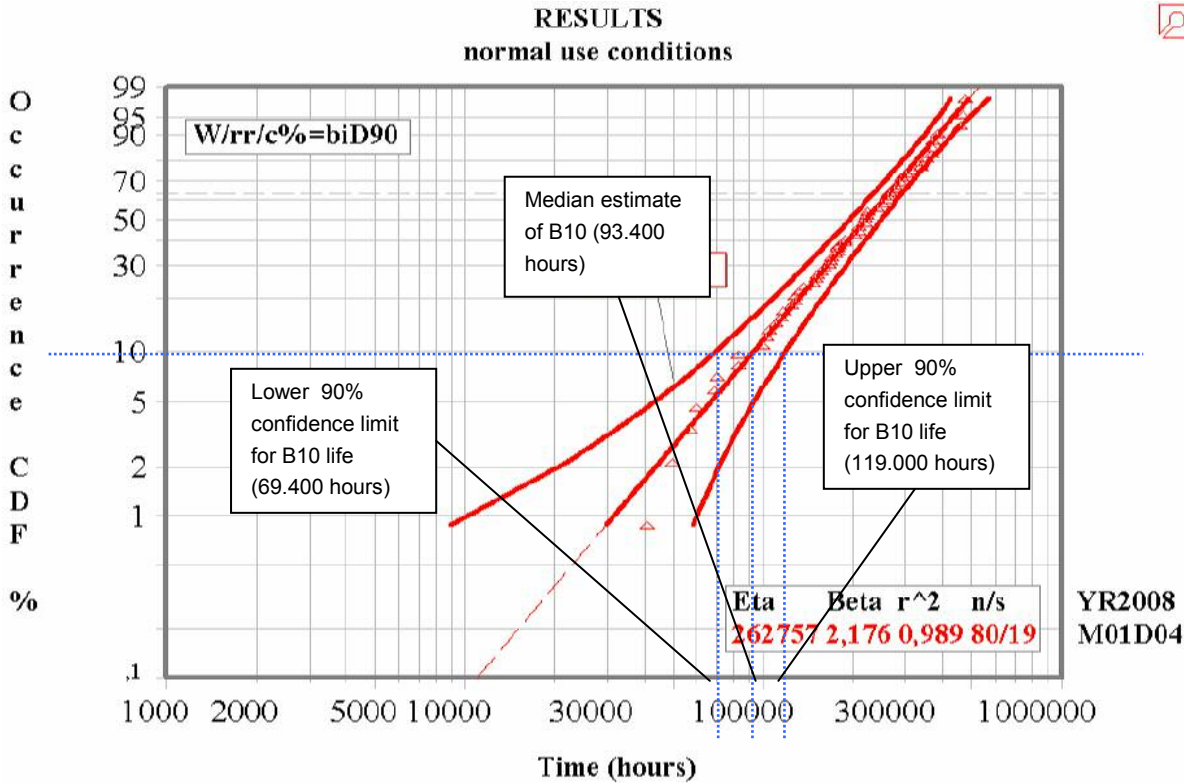
In the IEC Standard, an example is given for a batch of kWh-meters that is tested at five different temperature/humidity levels.

Example of the test program

	Test 1	Test 2	Test 3	Test 4	Test 5
Temp [°C]	85	85	85	75	65
Relative humidity [%]	95	85	75	95	95

About 30 meters per test condition will be tested.

Based on these test results, an acceleration factor is calculated. Based on the acceleration factor, an extrapolation to “standard” temperature and humidity can be made and the Weibull plot (lifetime including confidence level) can be made. This is shown in the following example:



The Weibull plot shows the following information:

- cumulative distribution function (CDF) is the probability that the variable takes a value less than or equal to  $x$ .
- the triangles shown in the graph are the actual failure data during the five tests extrapolated to normal use conditions
- the straight line is a fitted regression
- the  $n/s$  value shows the number of units being evaluated and the number of survivors,  $n-s$  is the number of failures
- Eta is the characteristic life (life at which 63% of population will fail), Beta is the Weibull slope or shape parameter which can provide clues to the physics of failures.

From this example it can be stated that, with a 90% confidence level, that 10% of these units could fail (B10) in as little as 69.400 hours but may survive as long as 119.000 hours. The best estimate is that 10% will fail at 93.400 hours.

***If you are interested or you want more information, please contact:***

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