IEC 62059-31-1

Edition 1.0 2008-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electricity metering equipment – Dependability –
Part 31-1: Accelerated reliability testing – Elevated temperature and humidity

Equipements de comptage de l'électricité – Sûreté de fonctionnement –
Partie 31-1: Essais de fiabilité accélérés – Température et humidité élevées

IEC 62059-31-1:2008

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ELECTRICITY METERING EQUIPMENT – DEPENDABILITY –

Part 31-1: Accelerated reliability testing – Elevated temperature and humidity

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62059-31 has been prepared by IEC technical committee 13: Electrical energy measurement, tariff- and load control.

The text of this standard is based on the following documents:

FDIS	RVD
13/1437A/FDIS	13/1444/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62059 series, under the general title *Electricity metering equipment – Dependability*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of December 2008 have been included in this copy.

INTRODUCTION

Electricity metering equipment are products designed for high reliability and long life under normal operating conditions, operating continuously without supervision. To manage metering assets effectively, it is important to have tools for predicting and estimating life characteristics of various types.

IEC 62059-41 provides methods for predicting the failure rate – assumed to be constant – of metering equipment based on the parts stress method.

IEC 62059-31-1 provides a method for estimating life characteristics using temperature and humidity accelerated testing.

It is practically impossible to obtain data about life characteristics by testing under normal operating conditions. Therefore, accelerated reliability test methods have to be used.

During accelerated reliability testing, samples taken from a defined population are operated beyond their normal operating conditions, applying stresses to shorten the time to failure, but without introducing new failure mechanisms.

The estimation is performed by recording and analysing failures during such accelerated testing, establishing the failure distribution under the test conditions and, using life stress models, extrapolating failure distribution under accelerated conditions of use to normal conditions of use.

The method provides quantitative results with their confidence limits and may be used to compare life characteristics of products coming from different suppliers or different batches from the same supplier.

ELECTRICITY METERING EQUIPMENT – DEPENDABILITY –

Part 31-1: Accelerated reliability testing – Elevated temperature and humidity

1 Scope

This part of IEC 62059 provides one of several possible methods for estimating product life characteristics by accelerated reliability testing.

Acceleration can be achieved in a number of different ways. In this particular standard, elevated, constant temperature and humidity is applied to achieve acceleration. The method also takes into account the effect of voltage and current variation.

Of course, failures not (or not sufficiently) accelerated by temperature and humidity will not be detected by the application of the test method specified in this standard.

Other factors, like temperature variation, vibration, dust, voltage dips and short interruptions, static discharges, fast transient burst, surges, etc. – although they may affect the life characteristics of the meter – are not taken into account in this standard; they may be addressed in future parts of the IEC 62059 series.

This standard is applicable to all types of metering equipment for energy measurement, tariff- and load control in the scope of IEC TC 13. The method given in this standard may be used for estimating (with given confidence limits) product life characteristics of such equipment prior to and during serial production. This method may also be used to compare different designs.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-191:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

IEC 60300-3-5 Ed. 1.0:2001, *Dependability management – Part 3-5: Application guide – Reliability test conditions and statistical test principles*

IEC 61649:2008, *Weibull analysis*

IEC 61703 Ed. 1.0: 2001, *Mathematical expressions for reliability, availability, maintainability and maintenance support terms*

IEC/TR 62059-11 Ed 1.0:2002, *Electricity metering equipment – Dependability – Part 11: General concepts*

IEC/TR 62059-21 Ed. 1.0:2002, *Electricity metering equipment – Dependability – Part 21: Collection of meter dependability data from the field*

IEC 62059-41 Ed. 1.0: 2006, *Electricity metering equipment – Dependability – Part 41: Reliability prediction*

IEC 62308 Ed. 1.0:2006, *Equipment reliability – Reliability assessment methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE 1 Here only those terms relevant to the subject are included, which have not been already included in IEC 62059-11.

3.1
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

NOTE To be valid, an accelerated life test shall not alter the basic fault modes and failure mechanisms, or their relative prevalence.

[IEV 191-14-07, modified]

3.2
ageing failure, wear-out failure
a failure whose probability of occurrence increases with the passage of time, as a result of processes inherent in the item

[IEV 191-04-09]

3.3
burn-in (for repairable hardware)
a process of increasing the reliability performance of hardware employing functional operation of every item in a prescribed environment with successive corrective maintenance at every failure during the early failure period

[IEV 191-17-02]

3.4
burn-in (for a non-repairable item)
a type of screening test employing the functional operation of an item

[IEV 191-17-03]

3.5
censoring
termination of the test after either a certain number of failures or a certain time at which there are still items functioning

[IEC 60300-3-5, 3.1.2]

3.6
constant failure intensity period
that period, if any, in the life of a repaired item during which the failure intensity is approximately constant

[IEV 191-10-08]

3.7
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]

3.8
equipment under prediction
EUP (abbreviation)
the electricity metering equipment for which a reliability prediction is being made

3.9
estimated
qualifies a value obtained as the result of the operation made for the purpose of assigning, from the observed values in a sample, numerical values to the parameters of the distribution chosen as the statistical model of the population from which this sample is taken

NOTE The result may be expressed either as a single numerical value (a point estimate) or as a confidence interval.

[IEV 191-18-04, modified]

3.10
extrapolated
qualifies a predicted value based on observed or estimated values for one or a set of conditions, intended to apply to other conditions such as time, maintenance and environmental conditions

[IEV 191-18-03]

3.11
failure
termination of the ability of an item to perform a required function

NOTE 1 After failure the item has a fault.

NOTE 2 “Failure” is an event, as distinguished from “fault”, which is a state.

[IEV 191-04-01, modified]

3.12
failure cause
the circumstances during design, manufacture or use which have led to a failure

NOTE The term “root cause of the failure” is used and described in IEC 62059-21 Clause 8.

[IEV 191-04-17, modified]

3.13
failure mechanism
the physical, chemical or other process which has led to a failure

[IEV 191-04-18]

3.14
failure rate acceleration factor
the ratio of the failure rate under accelerated testing conditions to the failure rate under stated reference test conditions

NOTE Both failure rates refer to the same time period in the life of the tested items.

[IEV 194-14-11]

3.15
fault
the state of an item characterized 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

NOTE A fault is often the result of a failure of the item itself, but may exist without prior failure.

[IEV 191-05-01]

3.16
fault mode
one of the possible states of a faulty item, for a given required function

NOTE 1 The use of the term “failure mode” in this sense is now deprecated.

NOTE 2 A function-based fault mode classification is described in IEC 62059-21 Clause 7.

[IEV 191-05-22, modified]

3.17
(instantaneous) failure rate
the limit, if it exists, of the quotient of the conditional probability that the instant of a failure of a non-repaired item falls within a given time interval $(t, t + \Delta t)$ and the duration of this time interval, Δt, when Δt tends to zero, given that the item has not failed up to the beginning of the time interval

NOTE 1 The instantaneous failure rate is expressed by the formula:

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \frac{F(t+\Delta t) - F(t)}{R(t)} = \frac{f(t)}{R(t)}$$

where F(t) and f(t) are respectively the distribution function and the probability density of the failure instant, and where R(t) is the reliability function, related to the reliability R(t1,t2) by R(t) =R(0,t).

NOTE 2 An estimated value of the instantaneous failure rate can be obtained by dividing the ratio of the number of items which have failed during a given time interval to the number of non-failed items at the beginning of the time interval, by the duration of the time interval.

NOTE 3 In English, the instantaneous failure rate is sometimes called "hazard function".

[IEV 191-12-02, modified]

3.18
item
entity
any part, component, device, subsystem, functional unit, equipment or system that can be individually considered

NOTE 1 An item may consist of hardware, software or both, and may also in particular cases, include people.

NOTE 2 A number of items, e.g. a population of items or a sample, may itself be considered as an item.

[IEV 191-01-01]

3.19
life test
test with the purpose of estimating, verifying or comparing the lifetime of the class of items being tested

NOTE The end of the useful life will often be defined as the time when a certain percentage of the items have failed for non-repaired items and as the time when the failure intensity has increased to a specified level for repaired items.

3.20
mean time to failure
MTTF (abbreviation)
the expectation of the time to failure

NOTE The term “expectation” has statistical meaning.

[IEV 191-12-07, modified]

3.21
mean time to first failure
MTTFF (abbreviation)
the expectation of the time to first failure

NOTE The term “expectation” has statistical meaning.

[IEV 191-12-06, modified]

3.22
measure (in the probabilistic treatment of dependability)
a function or a quantity used to describe a random variable or a random process

NOTE For a random variable, examples of measures are the distribution function and the mean.

[IEV 191-01-11]

3.23
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

NOTE The criteria for the exclusion should be stated.

[IEV 191-04-14]

3.24
non-repaired item
item which is not repaired after failure

[IEV 191-01-03]

3.25
operating time
time interval during which an item is in an operating state

[IEV 191-09-01]

3.26
population
the totality of items under consideration

3.27
prediction
the process of computation used to obtain the predicted value(s) of a quantity

NOTE The term “prediction” may also be used to denote the predicted value(s) of a quantity.

[IEV 191-16-01]

3.28
relevant failure
a failure that should be included in interpreting test or operational results or in calculating the value of a reliability performance measure

NOTE The criteria for the inclusion should be stated.

[IEV 191-04-13]

3.29
reliability test
experiment carried out in order to measure, quantify or classify a reliability measure or property of an item

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.

NOTE 2 Reliability test may include environmental testing.

3.30
stress condition
set of conditions to which the metering equipment is exposed during accelerated reliability testing

3.31
stress model
a mathematical model used to describe the influence of relevant applied stresses on a reliability performance measure or any other property of an item

[IEV 191-16-10]

3.32
time acceleration factor
the ratio between the time durations necessary to obtain the same stated number of failures or degradations in two equal size samples, under two different sets of stress conditions involving the same failure mechanisms and fault modes and their relative prevalence

NOTE One of the two sets of stress conditions should be a reference set.

[IEV 191-14-10]

3.33
time between failures
time duration between two consecutive failures of a repaired item

[IEV 191-10-03]

3.34
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]

3.35 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)

3.36
use condition
set of conditions to which the metering equipment is exposed during normal use