

Electricity metering equipment — Dependability —

Part 11: General concepts

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National foreword

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Sûreté de fonctionnement –**

**Partie 11:
Concepts généraux**

**Electricity metering equipment –
Dependability –**

**Part 11:
General concepts**



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**ELECTRICITY METERING EQUIPMENT –
DEPENDABILITY –****Part 11: General concepts**

FOREWORD

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IEC 62059-11, which is a technical report, has been prepared by IEC technical committee 13: Equipment for electrical energy measurement and load control.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
13/1197/DTR	13/1209/RVC

Full information on the voting for the approval of this technical report 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 3.

This document, which is purely informative, is not to be regarded as an International Standard.

INTRODUCTION

The present worldwide transition from electromechanical to static electricity metering equipment requires the application of the most recent results of reliability research to this new metering technology. This is of particular importance as metering equipment is expected to be in use for long unattended periods. The experience from more than a century of developing and manufacturing electromechanical meters is not entirely applicable to static meters, since both designs exhibit different failure modes.

It is for this reason that a working group was created to investigate the applicability of presently available standards to the dependability of static electricity metering equipment. A further reason for this decision was that the procedures applied during type approval and acceptance inspection are not adequate to determine the reliability of static electricity metering equipment during the products life cycles from specification and design to decommissioning.

The work program includes dependability management through data collection and analysis of field failure data, reliability testing, failure rate prediction and software aspects of dependability.

The dependability of any equipment is determined by factors such as its function, complexity, design, manufacturing process, failure criteria, operating conditions, elapsed time in use, installation and maintenance procedures. Some of these elements are under the control of the manufacturer, while other elements are under the responsibility of the operator and the user of the equipment. For this reason, no reliability and availability requirements are defined; this is left to negotiation between the parties involved.

ELECTRICITY METERING EQUIPMENT – DEPENDABILITY –

Part 11: General concepts

1 Scope

This part of IEC 62059 covers general aspects of the dependability of static metering equipment for electrical energy measurement and load control. It contains information on the role in dependability management of the various parties involved and on the methods applicable during the whole life cycle.

2 Reference documents

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

IEC 60300-3-2:1993, *Dependability management – Part 3: Application guide – Section 2: Collection of dependability data from the field*

IEC/TR 62051:1999, *Electricity metering – Glossary of terms*

IEC 62059-21, *Electricity metering equipment – Dependability, Part 21: Collection of meter dependability data from the field*¹

3 Terms and definitions

For the purposes of this part of IEC 62059, the terms and definitions of IEC/TR 62051:1999 and IEC 60050(191), as well as the following definitions apply.

3.1 availability

the ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided
[IEV-191-02-05]

3.2 category

a class or group of objects which have the same quality in common

3.3 classification

systematic placement into categories; alternatively, division of specimens or items into categories using one or more sorting factors

¹ To be published.

3.4

dependability

the collective term used to describe the availability performance and its influencing factors: reliability performance, maintainability performance and maintenance support performance

NOTE Dependability is used only for general descriptions in non-quantitative terms.

[IEV-191-02-03]

3.5

failure

the 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.

NOTE 3 This concept as defined does not apply to items consisting of software only.

[IEV 191-04-01]

Remark: The above definition raises the issue of functions. A functional failure can be defined as the inability of any physical asset to meet the required standard of performance.

3.6

functional testing

way to test the specified functions of a system without regard to its internal structure

NOTE The objective is direct determination of the capability of the system to meet its input-output specifications. Functional testing is sometimes called "black box" testing.

3.7

(instantaneous) failure rate

the limit, if this exists, of the ratio of the conditional probability that the instant of time, T , of a failure of an 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 is in an up-state at the beginning of the time interval

NOTE In this definition, T may also denote the time to failure or the time to first failure, as the case may be.

[IEV 191-12-02, modified]

3.8

maintainability

the ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources

NOTE The term "maintainability" is also used as a measure of maintainability performance.

[IEV 191-02-07]

3.9

maximum error in service

me_s

maximum error measured for a given measuring instrument in service

3.10

maximum permissible error in service

mpe_s

extreme value of an error permitted by specification, regulations, etc., for a given measuring instrument in service

3.11**maximum error during verification***me_v*

maximum acceptable value of an error of a meter during verification. The limit of this value depends on the accuracy class of the meter.

3.12**mean down-time***MDT*

the expectation of the down-time between operational time periods

3.13**mean up-time***MUT*

the expectation of the operating time interval of a metering equipment (being ready to perform the required functionality)

3.14**mean time between failures***MTBF*

the expectation of the operating time between failures

[IEV 191-12-09, modified]

3.15**product specification**

document which defines the parameters that are used for determining the expected performance of a product

3.16**redundancy**

in an item, the existence of more than one means for performing a required function

[IEV 191-15-01]

3.17**reliability**

the probability that an item can perform a required function under given conditions for a given time interval (t_1 , t_2).

NOTE 1 It is generally assumed that the item is in a state to perform this required function at the beginning of the time interval.

NOTE 2 The term "reliability" is also used to denote the reliability performance quantified by this probability.

[IEV 191-12-01]

3.18**structural testing**

way to test the specified functions of a system with regard to its internal structure

NOTE Structural tests are performed by testing a subset of all possible paths in the system instead of all possible input combinations. Tests are derived from the program structure, derived from the specifications. Structural testing is also known as "white box" or "glass box" testing.

3.19**useful life**

Under given conditions, the time interval beginning at a given instant of time, and ending when the failure intensity becomes unacceptable or when the item is considered unrepairable as a result of a fault

[IEV 191-10-06]

4 Basic concepts and methods of dependability management

4.1 General

This technical report deals with all types of static metering equipment for electrical energy measurement and load control. Therefore, it is necessary to describe and define the main elements of the metering system life cycles and the role of all parties involved. It is thus assumed that the meters are:

- designed, manufactured and tested;
- subjected to type test, approval and initial verification, if required;
- monitored during their useful life to verify that they are installed, measuring and functioning correctly;
- removed and replaced as soon as they are found to be faulty.

During its useful life, metering equipment performance should be monitored to ensure that it is functioning properly. This may be subject to local requirements set by legal bodies. All other parameters may be negotiated freely by the parties involved or determined through reference to internationally recognized standards.

4.2 Relationship between reliability, maintainability and dependability

The availability of electricity metering equipment to users is an essential requirement, since it determines the quality of the measuring service. To maintain quality of supply, supply to the user has to be continued even after a metering equipment failure, since it would be unacceptable for the user to disconnect supply for such a reason. This also means that some electricity consumption may not be measured after a failure. This problem can only be correctly avoided by maintaining high availability of metering equipment.

Availability can be calculated from two parameters: the mean up-time (*MUT*) during which the metering equipment is ready to perform its function and the mean down-time (*MDT*), the time necessary to discover the fault, to replace the equipment, etc.

If exponential distributions of up- and down-time intervals are assumed, i.e. constant failure rate λ and constant repair rate μ , then the mean up-time (*MUT*) and mean down time (*MDT*) can be calculated. The two parameters are intertwined in steady-state situations by the equation:

$$A = \frac{MUT}{(MUT + MDT)}$$

This means that the reliability of metering equipment may be traded against a utility's maintenance service performance to achieve the same availability in all cases. This will provide a sound basis for negotiations between the manufacturer and the utility company to decide on equipment reliability and the mean maintenance response time (equal to *MDT*).

Once the reliability target is thus determined, manufacturers will then be able to produce meters to meet the requirements of both the utilities and legal bodies, if any.

An example is given in Annex A.

4.3 Reliability data collection and analysis

4.3.1 Data available before normal use

It is useful to have information on design parameters regarding the failure rate of the metering equipment before data are collected from the field. Data collected from other metering equipment types of similar design may also be used.

The underlying model and the method of calculating the failure rate should be agreed upon, because different models and calculations may lead to different reliability figures.

A specification for a “parts count and stress” prediction method, which can be used for estimation of the value of the failure rate of the metering equipment, is under consideration.

4.3.2 Data available from the field

The general objectives of field data collection, evaluation and presentation are specified in clause 4 of IEC 60300-3-2:1993.

Reliability and availability performance of metering equipment can be assessed by collecting data from the field using the method described in IEC 62059-21.

4.3.2.1 Data to be collected

IEC 60300-3-2:1993, clause 6 defines the data required in general. For metering equipment in particular, they are specified in IEC 62059-21.

This technical report has selected a functional (black box) approach for the purposes of data collection.

4.3.2.2 Classification of failures

It is in the interest of all stakeholders that a common approach to the classification of failures is adopted. In order that the reliability data can be understood and compared, a common language should be used (see IEC 62059-21).

4.3.2.3 Presentation of results

For presentation of results, the following facts shall be considered:

- operating conditions;
- length of time period of equipment in use;
- number of devices in use;
- classification of equipment.

Reporting shall be made for homogenous equipment groups. It is also recommended to have at least a one-year time-in-use period for statistical confidence. Only relevant failures are taken into account as defined in IEC 62059-21.

The presentation should follow the general requirements laid down in IEC 60300-3-2:1993, clause 8.

4.3.3 Reliability testing

Furthermore, reliability data may be obtained from reliability testing. A method for accelerated reliability testing is under consideration.

For the purposes of reliability testing, either the functional approach (black box) or a structural approach (white box) may be taken.

4.3.4 Software aspects of dependability

Software aspects are under consideration.

5 The role of stakeholders in dependability management

In electricity metering dependability, the following four categories of stakeholders are identified:

- equipment suppliers/manufacturers;
- utilities/energy providers/meter operators;
- electricity users or consumers;
- legal bodies.

They all have their specific interests and role in dependability management.

5.1 Suppliers/manufacturers

It is the manufacturer's business to design and manufacture metering equipment which meets the requirements of international and national standards, legal regulations and the specific needs of other stakeholders concerning reliability objectives. The manufacturer should be able to indicate the failure rate, which can be expected for a given metering equipment.

5.2 Utilities/energy providers/meter operators

These stakeholders provide electrical energy and/or operate metering equipment and may have to comply with legal requirements in order to bill users correctly for the energy consumed.

It is the responsibility of these stakeholders to provide adequate specifications for metering equipment. If these specifications include reliability requirements, these should follow the principles given in the IEC 62059 series of standards.

While meters are required to operate continuously, they may have to be monitored from time to time. In order to maintain acceptable levels of quality of service, meters deemed to be faulty need to be identified and replaced with meters that conform to the requirements.

It is also the responsibility of these stakeholders to provide field data for reliability study purposes. It is important that this information is properly recorded and the faults are properly analyzed.

5.3 Electricity users

Users have the following major requirements:

- accuracy of their metering equipment should be maintained at all times;
- they should not be inconvenienced by metering equipment failures.

5.4 Legal bodies

Legal bodies are responsible for setting the necessary regulations and processes to ensure correct measurement of electricity supply. For this purpose, they may set metrology and dependability requirements. Their activities are not covered in this technical report.

Annex A

Availability of energy supply metering equipment at user's outlets

Assuming a constant failure rate model, a meter's reliability function is described by $R = e^{-\lambda t}$.

EXAMPLE With a failure rate of 0,2 % per year, after one year 99,8 % of the meters would still measure correctly. The *MUT* then equals 500 years.

Finding, repairing or replacing all faulty meters within a given year would ensure that, at the end of the year, all the meters were functioning correctly. The same process can then be repeated in the following years to maintain the same level of availability.

For example, in the case of reading cycles once per year, and if upon meter reading, faulty meters are detected and replaced, the mean time to detect a faulty meter would be half a year, provided that the failures were equally distributed over the course of the year. This period then equals *MDT*. The availability of the electric energy metering service to the user would then be 99,9 %.

Figure A.1 shows the availability of a meter batch as a function of the failure rate. The parameters of the curves represent the meter reading interval.

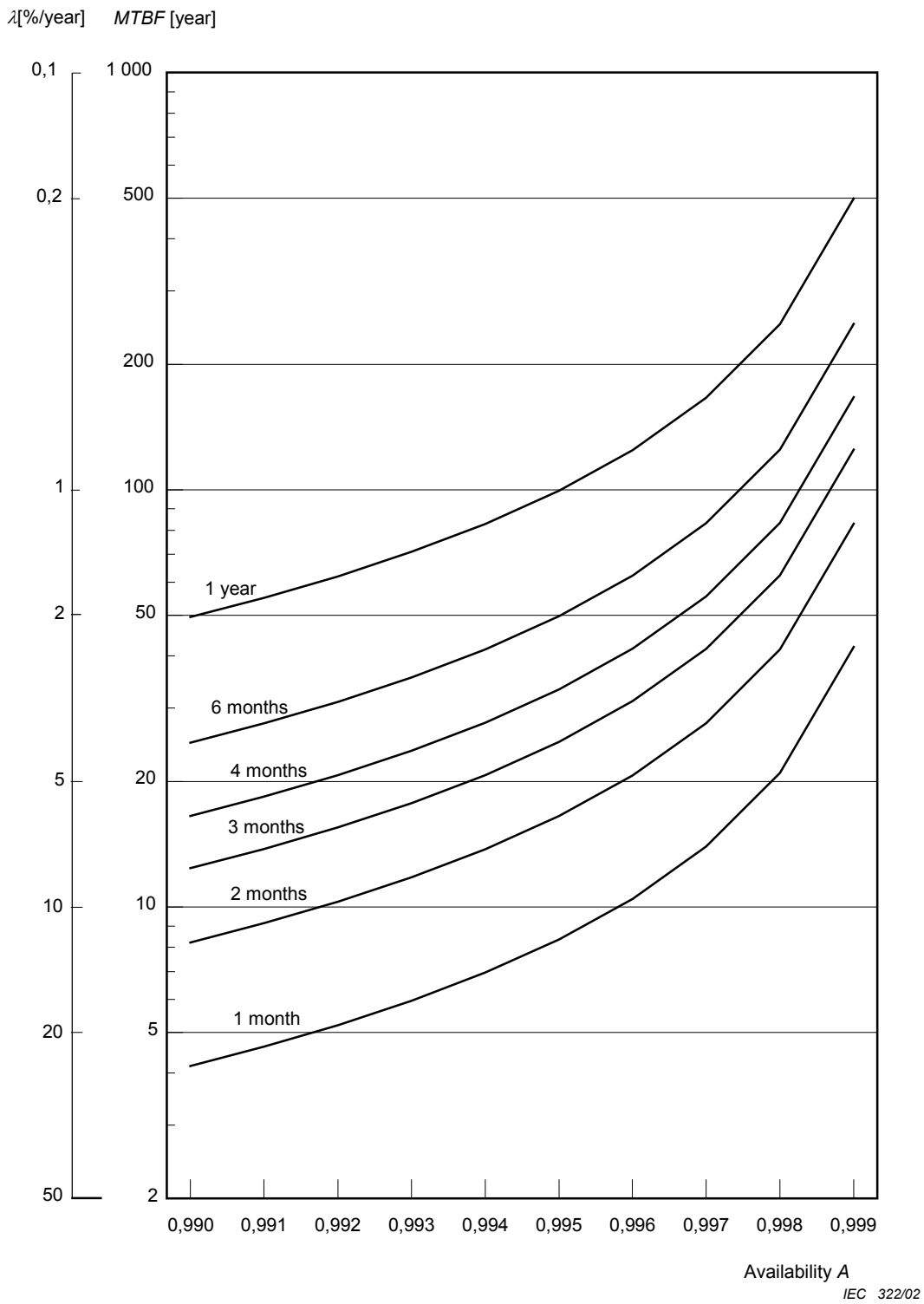


Figure A.1 – Failure rate as a function of availability and meter reading interval

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