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Reliability of systems, equipment and components —

Part 20: Guide to the specification of dependability requirements

ICS 03.120.10; 29.020

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee DS/1, Reliability and maintainability systems, upon which the following bodies were represented:

Association of Consulting Engineers
Association of Project Managers
British Gas plc
British Railways Board
British Telecommunications plc
Chartered Institution of Building Services Engineers
City University
Civil Aviation Authority
Consumer Policy Committee of BSI
Cranfield University
Defence Manufacturers' Association
Department of Trade and Industry (Standards Policy Unit)
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Contents

National foreword

This Part of BS 5760 has been prepared by the Technical Committee DS/1 and is identical with IEC 300-3-4:1996 *Dependability management — Part 3: Application guide — Section 4: Guide to the specification of dependability requirements,* published by the International Electrotechnical Commission (IEC).

This standard gives guidance on specifying dependability characteristics in product and equipment specifications, including specifications on procedures and criteria for verification.

BS 5760 provides comprehensive guidance on many aspects of reliability management.

The Parts so far published are as follows:

— *Part 0: Introductory guide to reliability;*

— *Part 1: Dependability programme elements and tasks;*

— *Part 2: Guide to the assessment of reliability;*

— *Part 3: Guide to reliability practices: examples;*

— *Part 4: Guide to specification clauses relating to the achievement and development of reliability in new and existing items;*

— *Part 5: Guide to failure modes, effects and criticality analysis (FMEA and FMECA);*

— *Part 6: Guide to programmes for reliability growth;*

— *Part 7: Guide to fault tree analysis;*

— *Part 9: Guide to the block diagram technique;*

— *Part 10: Guide to reliability testing;*

— *Section 10.1: General requirements;*

— *Section 10.2: Design of test cycles;*

— *Section 10.3: Compliance test procedures for steady-state availability;*

— *Section 10.5: Compliance test plans for success ratio;*

— *Part 11: Collection of reliability, availability, maintainability and maintenance support data from the field;*

— *Part 12: Guide to the presentation of reliability, maintainability and availability predictions;*

— *Part 13: Guide to reliability test conditions for consumer equipment;*

— *Section 13.1: Conditions providing a low degree of simulation for indoor portable equipment;*

— *Section 13.2: Conditions providing a high degree of simulation for equipment for stationary use in weather-protected locations;*

— *Section 13.3: Conditions providing a low degree of simulation for equipment for stationary use in partially weather-protected locations;*

— *Section 13.4: Conditions providing a low degree of simulation for equipment for portable and non-stationary use;*

— *Section 13.5: Ground mobile equipment — Low degree of simulation;*

— *Section 13.6: Test cycle 6: Outdoor transportable equipment — Low degree of simulation;*

— *Part 14: Guide to formal design review;*

— *Part 15: Guide to the application of Markov techniques;*

— *Part 16: Guide to stress screening;*

— *Section 16.1: Repairable items manufactured in lots;*

— *Part 17: Reliability growth — Statistical test and estimation methods;*

— *Part 18: Reference conditions for failure rates of electronic components and stress models for conversion;*

— *Part 23: Guide to life cycle costing.*

Further Parts of BS 5760 are envisaged in order to provide guidance on other techniques of reliability management.

NOTE Part 8: *Guide to the assessment of reliability of systems containing software* is currently in preparation and is available as DD 198:1991.

Whilst mainly addressing system and equipment level reliability, many of the techniques described in the Parts of BS 5760 may also be applied at the component level. Further guidance on component reliability is given in BS CECC 00804:1996.

Cross-references

The British Standards which correspond to international or European publications referred to in this document may be found in the current BSI Catalogue under the section entitled "International Standards Correspondence Index".

The Technical Committee has reviewed the provisions of IEC 300-2:1995, IEC 300-3-1:1991, IEC 319:1978, IEC 409:1981 and IEC/FDIS 1124, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 8 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Introduction

In many products, reliability, maintainability and availability are essential performance characteristics. These characteristics, together with maintenance support performance are known collectively as dependability.

In products where reliability, availability and maintainability are important, it is necessary that these characteristics should be defined and specified in the same way as other product characteristics such as technical performance, dimensions, mass, etc.

The levels of reliability, maintainability, availability and maintenance support performance achieved by a product depend on the conditions under which the product is used. When requirements for dependability characteristics are specified, it is necessary to define the conditions of storage, transportation, installation and use that will be applied to the product. It may be important to take account not only of the conditions under which the product will operate, but also of the maintenance policy and organization for maintenance support of the product.

In order to assess the values of the dependability characteristics achieved it is necessary to use statistical methods.

Dependability characteristics may be specified, like other performance characteristics, in three types of specifications:

— **specifications produced by the supplier**

These are mainly used for products that need to have certain dependability characteristics, for example reliability, in order to be accepted in the market place.

— **specifications produced by the customer**

These are mainly used for standard products that have to meet certain dependability characteristics in order to satisfy the customer's needs.

— **specifications mutually agreed or produced by the supplier and the customer**

These are normally used in the case of custom-made products or alterations to an existing design.

1 Scope

This section of IEC 300 gives guidance on specifying required dependability characteristics in product and equipment specifications, together with specifications of procedures and criteria for verification.

The guidance provided includes the following:

— advice on specifying quantitative and qualitative reliability, maintainability and availability requirements;

— advice to customers of a product to help them to ensure that the specified requirements will be fulfilled by suppliers;

— advice to suppliers to help them to meet customer requirements.

NOTE 1 It is not the intention of this standard to give guidance on the management of reliability and maintainability programmes or on the various activities necessary to fulfil stated reliability, maintainability and availability requirements. For this general guidance see other parts of IEC 300.

NOTE 2 Safety specifications are not considered in this guide.

NOTE 3 Guidance for the inclusion of reliability clauses in specifications for components (or parts) for electronic equipment is given in IEC 409.

NOTE 4 Guidance for presentation of reliability data on electronic components can be found in IEC 319.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 300-3. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 300-3 are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(191):1990, *International Electrotechnical Vocabulary (IEV) — Chapter 191: Dependability and quality of service*.

IEC 300-1:1993, *Dependability management — Part 1: Dependability programme management*.

IEC 300-2:1995, *Dependability management — Part 2: Dependability programme elements and tasks*.

IEC 300-3-1:1991, *Dependability management — Part 3: Application guide — Section 1: Analysis techniques for dependability: Guide on methodology*.

IEC 300-3-2:1993, *Dependability management — Part 3: Application guide — Section 2: Collection of dependability data from the field*.

IEC 319:1978, *Presentation of reliability data on electronic components (or parts)*.

IEC 409:1981, *Guide for the inclusion of reliability clauses into specifications for components (or parts) for electronic equipment*.

IEC 605-1:1978, *Equipment reliability testing — Part 1: General requirements*.

IEC 605-6:1986, *Equipment reliability testing — Part 6: Tests for the validity of a constant failure rate assumption*.

IEC 706-1:1982, *Guide on maintainability of equipment — Part 1: — Sections 1, 2 and 3: Introduction, requirements and maintainability programme*.

IEC 706-3:1987, *Guide on maintainability of equipment — Part 3: — Sections 6 and 7: Verification and collection, analysis and presentation of data*.

IEC 706-5:1994, *Guide on maintainability of equipment — Part 5: — Section 4: Diagnostic testing*.

IEC 706-6:1994, *Guide on maintainability of equipment — Part 6: — Section 9: Statistical methods in maintainability evaluation*.

IEC 863:1986, *Presentation of reliability, maintainability and availability predictions*.

IEC 1070:1991, *Compliance test procedures for steady-state availability*.

IEC 1123:1991, *Reliability testing — Compliance test plans for success ratio*.

IEC/FDIS 1124, *Reliability testing — Compliance test plans for constant failure rate and constant failure intensity* (under preparation).

ISO 8402:1994, *Quality management and quality assurance — Vocabulary*.

ISO 9000-4:1993, *Quality management and quality assurance standards — Part 4: Guide to dependability programme management*.

3 Definitions

For the purpose of this section of IEC 300-3, the definitions given in IEC 50 (191) and ISO 8402 apply, and in particular the following:

3.1
dependability

the collective term used to describe the availability performance and its influencing factors: reliability performance, maintainability performance and maintenance support performance [IEV 191-02-03]

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

3.2
organization

company, corporation, firm, enterprise or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration [ISO 8402]

3.3
supplier

organization that provides a product to the customer [ISO 8402]

3.4
customer

recipient of a product provided by the supplier [ISO 8402]

3.5
verification

confirmation by examination and provision of objective evidence that specified requirements have been fulfilled [ISO 8402]

4 General considerations when specifying dependability requirements

All reliability, maintainability and availability requirements should be expressed quantitatively wherever possible, but it may also be appropriate to specify qualitative requirements in the specifications. Requirements are determined according to the needs of customers and how it is intended to use the product.

Requirements should be realistic and should be compatible with the technological state of the art.

Where a customer/supplier agreement is involved, the requirements should form a part of the agreement.

The specification should also specify the procedures to be used to verify that the specified reliability, maintainability or availability performance is met. It is essential that the dependability performance requirements are verifiable and the methods of verification should be mutually agreed.

It is particularly important to define precisely:

— the product under consideration for example, the system, equipment or assembly to which the requirements apply;

— the exact criteria by which reliability, maintainability or availability are to be judged. It is especially important to define exactly what constitutes a product fault, if necessary, by reference to a detailed performance specification.

It is the responsibility of the supplier to ensure that the product conforms to the required reliability, availability and maintainability performances, taking into account:

— the form in which the requirements are expressed;

— the arrangements for maintenance support;

— the methods to be used to assess the required characteristics.

The levels of reliability and maintainability performance achieved by a product are strongly influenced by the conditions in which it is installed and operated. When specifying dependability requirements it is important to state the following:

— the intended function of the product (equipment or system);

— how the equipment will be installed and used;

— the definition of fault, that is what constitutes a fault in this particular item in the intended application;

— the obligations and responsibilities of customer, supplier and any third parties;

— the various operating and environmental conditions under which the equipment is used including, where applicable, the relative amount of time spent in each condition;

— the methods intended to be applied for verification of compliance with the requirements;

— the qualifications and responsibilities of the personnel responsible for operating and maintaining the equipment;

— the maintenance policy to be applied and the associated procedures and support arrangements.

NOTE The level of maintenance support is very often determined by the conditions of use and is not an intrinsic requirement of the product itself.

The dependability characteristics selected for specification should be related to the type of product and the intended application, for example only reliability requirements need to be specified if no maintenance actions are intended.

Maintainability performance requirements should be specified for equipment if the maintenance costs contribute significantly to life-cycle cost or if maintenance is important for the user. Preventive maintenance requirements may be specified, if applicable.

Availability performance requirements are generally specified for products (systems) where down time could cause considerable economic loss or personnel injury, for example, large systems, production plants, medical equipment, safety equipment. Availability performance can be calculated from the system configuration, its subsystems and their reliability performance and maintainability performance requirements, if stated, and by taking into account the maintenance support performance.

The dependability specification should draw attention to the various factors likely to affect the cost of reliability and maintainability assurance. This includes the expected lifetime and disposal or recycling of the product.

5 Specifying reliability performance

5.1 Reliability requirements

5.1.1 *Quantitative requirements*

Reliability performance requirements should be quantitative and should be specified before design of the product begins.

For every product it is necessary to select and define each reliability characteristic that is required and to specify a quantitative requirement for each characteristic. When specifying quantitative requirements for an item it is important to state the following:

— the item's application;

— the definition of a fault, i.e, what constitutes a fault in the particular item in the intended application;

NOTE A fault may be defined in various ways according to the consequences, for example, the loss of a service, the need for repair.

— the operating conditions;

— the environmental conditions;

— the methods intended to be applied for the verification of compliance with the requirements.

Without such statements the specification of a reliability performance measure such as MTTF, MTBF and R(t) would be meaningless.

When selecting the value of the reliability performance measure to be specified the following factors should be taken into account:

— limits imposed by the technological state of the art (see clause **4**) and the nature and complexity of the product (equipment or system);

— the experience of the user in operating and maintaining the particular type of equipment;

— the feasibility of verifying the specified requirement;

— the reliability level of units, components etc., from which the item can be manufactured;

— the cost of design, production and verification of the item with a specified level of reliability.

If, during the development of a project, it becomes evident that the underlying assumptions are not valid, the reliability performance requirements may have to be reconsidered and changed. If the specification is to be changed this should only be done with the agreement of all the parties concerned.

The quantitative requirements should be clearly specified in a form against which it will be possible to compare the results subsequently obtained.

Where verification of conformity to the quantitative requirements is to be done through testing, as described in **5.2.1**, it is necessary to specify the confidence level required, or to specify the actual test plan to be used. If a test plan is specified the specification should include the test duration and the acceptance/rejection criteria.

If the specified reliability performance measure is known, or is likely to vary with time, the dependency should be specified by, for example, specifying a mean failure intensity over the first months of use. See IEC 605-1 for information on statistical distribution.

5.1.2 *Qualitative requirements*

Qualitative reliability requirements may be expressed in terms of either or both of the following:

— design criteria for the product;

— reliability improvement activities to be applied during the product life-cycle phases.

Design criteria for a product usually stand alone, but may also be complementary to quantitative reliability requirements. Such criteria may indirectly impose reliability requirements for the product itself and for the way the product is installed and its performance is monitored. Some examples are as follows:

— single fault criterion, i.e. the product has to be such that no single fault can lead to a critical state of the product;

— accumulating fault criterion, i.e. the product has to be such that no undetected fault, when combined with additional faults, can cause system failure;

— path separation, i.e. redundant subsystems have to be kept independent by using separate paths for cables, pipes etc., for signalling channels, power supply and other supporting supplies;

— monitoring of critical functions, i.e. provision has to be made for automatic or manual checking of critical functions either continuously or at intervals, in order to maintain a specified level of reliability performance.

In addition to specifying quantitative reliability performance requirements, it may often be advisable to specify a sequence of reliability (and maintainability) improvement activities to be implemented during product life-cycle phases. Such qualitative requirements may be applied to hardware, software and support. These activities are particularly important if the quantitative requirements do not specify with sufficient precision the reliability performance of the product. They should be mutually agreed between customer and supplier, both technically and in terms of time schedule and cost. Such qualitative requirements should be formalized in and managed through a reliability programme plan (or dependability plan), as specified in IEC 300-2.

The reliability programme plan should be tailored according to the nature of the product and the requirements specified, and typically includes the following:

— the types of analysis methods to be applied;

— a reliability growth programme, if necessary;

— statements about how to verify conformity to the requirements (see IEC 605-1) or any other qualitative or quantitative measure to be used for expressing the degree of conformity to the requirements;

— criteria for component selection and arrangements for quality assurance;

— worst case analysis.

5.2 Reliability verification

5.2.1 *General*

The specification should state the methods to be used to verify that the specified requirements have been met.

Reliability verification may be done either by analysis during the design and before production, by laboratory tests or field tests after production or by field performance evaluation after delivery.

Subclauses **5.2.2** and **5.2.3** give guidance on the possible verification methods and their implications.

5.2.2 *Verification by field or laboratory testing*

Preferred methods of verification testing include:

— the collection and analysis of failure data from products in the field i.e. in actual use;

— testing products in the field or in the laboratory, using compliance or determination tests as described in IEC 1123.

Precise criteria should be specified to enable all failures in hardware and software etc. to be classified into relevant or non-relevant categories.

This classification is the basis of the acceptance/rejection criteria and it is essential that it should be clearly and precisely specified before the tests start.

Verification procedures are normally selected by agreement between the customer and supplier from either field tests or laboratory tests, as follows:

— field tests are often preferred, but their validity requires sufficient data collection. See IEC 605-1 and IEC 300-3-2 for the requirements to be stated;

— laboratory tests should be conducted as described in IEC 605-1. When specifying laboratory tests, it is important to consider the associated factors such as cost and time.

The verification of reliability performance measures for repaired and non-repaired products have each to be considered separately.

If success ratio is used as the reliability performance measure, the test should be carried out in accordance with IEC 1123.

If reliability performance requirements are based on a constant failure rate or failure intensity assumption it is necessary to select an appropriate test plan in accordance with IEC/FDIS 1124. Tests for validation of this assumption can be found in IEC 605-6.

5.2.3 *Verification by analysis*

Reliability verification of a product can be made prior to delivery by calculation based on reliability analysis. This method can be used long before reliability validation during field operation or by laboratory testing is possible. Such a method can only determine by analysis whether the product to be delivered fulfils corresponding requirements laid down in the product specification; it does not measure the realized reliability directly.

Examples of analytical methods for reliability verification of an item such as a system with hardware and software include reliability block diagrams, fault trees, state diagrams and fault mode and effect analysis. IEC 300-3-1 gives guidance on various analysis tools.

The hardware part of a system should be analysed to establish that the failure rates of each of its subsystems, parts and electronic or other components are adequately derived and take into account the expected stress. Electrical, thermal or other measurements may be necessary for this purpose.

The software part of the system should be similarly analysed to identify possible software fault modes and evaluate qualitatively their impact on the reliability performance of the system.

Data for such calculations can be based, for example, on results obtained from operational experience with similar equipment in the field, from laboratory tests, from software/hardware integration or from recognized data sources. If the customer intends to specify the use of a certain data base (for example, a particular failure rate data bank), this should be agreed between the supplier and the customer. Specifying the use of a certain data base, however, does not relieve the supplier of his obligation to achieve the required reliability performance. In all cases, the data source should be identified and recorded.

IEC 863 gives guidance on the presentation of reliability, maintainability and availability predictions.

6 Specifying maintainability performance

6.1 Maintainability requirements

Maintainability requirements may be quantitative or qualitative. Where quantitative requirements are specified it is important to specify how long an item is expected to be in a non-operating state due to maintenance or maintenance support. This time has to be specified in terms of appropriate measures such as mean or fractile repair time, or mean or fractile logistic delay. Where qualitative requirements are specified, it is necessary to specify the degree to which an item has to conform to specific conditions and constraints related to maintenance.

A complete specification of maintainability performance requirements should cover four broad areas:

— the maintainability performance to be achieved by the design of the item;

— the constraints that will be placed on the use of the item which will affect maintenance;

— the maintainability programme requirements to be accomplished by the supplier to assure that the delivered item has the required maintainability characteristics;

— the provision of maintenance support planning.

When specifying maintainability requirements it is important to state the following:

— the various operating and environmental conditions under which the equipment is used;

— the qualifications and responsibilities of the personnel responsible for operating and maintaining the equipment;

— the maintenance policy to be applied and the associated procedures and support arrangements.

The maintainability performance specification should detail the requirements and the method to be followed to achieve them. It should also include precise definitions of terms used in the specification with references to standard vocabularies as appropriate.

Maintainability requirements may be specified in the specification either as targets or as definite requirements that are to be verified in accordance with prescribed procedures. Targets or requirements may be specified in either quantitative or qualitative terms.

A maintainability performance specification typically covers the various aspects of maintainability achievement at the operational level. However, since maintainability performance as a product characteristic affects maintenance support costs and can also affect maintenance times at different maintenance levels, requirements should be included in the specification covering achievements at all levels affected by the maintenance policy.

More detailed guidance on maintainability performance requirements in specifications and contracts, is provided in IEC 706-1, Section 2, clause **6**.

6.2 Maintainability verification

Verification of maintainability performance is the process of determining that the requirements in the specification have been met. The methods and procedures for verification should be specified with the maintainability requirements. Methods of verification may range from the submission by the supplier of appropriate data or information to a requirement to perform a special maintainability demonstration.

Maintainability verification should be regarded as a continuous process. Maintainability related data should be generated, collected and evaluated as they become available in the course of project development, and the results should be compared constantly with specified maintainability requirements.

Several methods of verifying maintainability performance are described in IEC 706-3; they include the following:

— analysis and review of maintainability characteristics;

— special studies;

— demonstration tests;

— review of operational experience.

The specification may give guidance on, or may specify which of the above methods is to be applied.

Further information on maintainability verification is given in IEC 706-3, Section 6. Information concerning diagnostic testing is given in IEC 706-5 and statistical methods in maintainability evaluation in IEC 706-6.

7 Specifying availability performance

7.1 General

For some products, such as complex systems, it is necessary to consider redundancy and maintenance together. In such products, it may be appropriate at system level to specify availability requirements rather than separate reliability and maintainability requirements. Requirements for the steady-state availability are the most commonly used.

7.2 Availability requirements

7.2.1 *General*

Requirements for steady-state availability can be expressed as a decimal fraction or as a percentage, for example, mean up time as a percentage of observation time. Availability requirements cover both the occurrence of failures and down time.

NOTE It is important not to over-specify the requirements. It is neither necessary nor desirable to specify all three dependability characteristics (availability performance, reliability performance and maintainability performance). Two of the three are sufficient.

On the other hand, it is often insufficient to specify only the availability performance. A reliability performance measure such as failure intensity should also be specified.

7.2.2 *Quantitative requirements*

When specifying quantitative availability requirements, it is usual to accumulate the down times occurring over a certain time period (for example, a month or a year).

If part of the system down time is excluded from the responsibility of the supplier (for example, logistic or administrative delay), this should be noted in the specification together with a statement of the values of the times concerned. Figure 191-10 in IEC 50(191) gives guidance on the various maintenance times. Alternatively, an intrinsic availability may be specified, that is by excluding such times.

7.2.3 *Qualitative requirements*

Qualitative availability requirements should only be specified if the quantitative requirement does not specify the availability performance of the item with sufficient precision. For example, if down time under certain operating conditions is more critical.

7.3 Availability verification

7.3.1 *General*

The specification or contract may include the need for verification of the required availability performance.

7.3.2 *Verification by field or laboratory testing*

Where verification is to be carried out by laboratory or field testing, the standardized compliance test procedures for steady-state availability given in IEC 1070 may be applied. It should be noted, however, that for very high availability requirements (for example, $\bar{A} > 0{,}9999$) it is very difficult to establish a meaningful verification plan. Evaluation and verification of subsystem performance can assist in this activity. This can be achieved by using observations at system and subsystem level in a system availability model. In any case, the feasibility of the methods applied to verify high availability requirements needs to be proven.

For field verification, a detailed field data collection program should be agreed and be performed (see IEC 300-3-2), including down time due to hardware failures, software failures, maintenance procedures and other reasons.

Furthermore, if more than one item of the same type of product is installed, the number of items and the period of observation should be stated. A procedure should be specified such that, in the event of non-compliance, an improvement is agreed and introduced and testing is continued.

7.3.3 *Verification by analysis*

If verification is to be carried out by prediction methods, the standardized prediction techniques given in IEC 863 with detailed analysis methodology as specified in IEC 300-3-1 may be applied.

Generally, data for calculation shall be based on recognized sources of data, results obtained from operational experience on similar equipments in the field, laboratory tests or from software/hardware integration. The data should be agreed between the supplier and the customer. The data source should be recorded.

8 Specifying maintenance support

8.1 General

Maintenance support specifications can be supplied fully or partly by the manufacturer of the equipment. The customer (including the user) may also supply the maintenance support partially or fully.

To the extent that the maintenance support is supplied by the manufacturer it should be specified as part of the delivery. Maintenance support by the customer (including the user) will be part of the specified conditions of operation of the equipment, a prerequisite for the stated reliability and availability values.

When specifying maintenance support requirements, it is important to state the following:

— the various operating and environmental conditions under which the equipment is used;

— the obligations and responsibilities of customer, supplier and third parties;

— the maintenance policy to be applied and the associated procedures and support arrangements;

— the qualifications and responsibilities of the personnel responsible for operating and maintaining the equipment.

The maintenance support specifications should be specified before design of the product begins and be updated before delivery of the equipment.

8.2 Quantitative requirements

Maintenance support requirements should, where possible, be specified in a quantitative way. Examples of such quantitative specifications are mean administrative delay, mean logistic delay and spare shortage probability. Further information can be found in IEC 706-1 and IEC 706-6.

8.3 Qualitative requirements

Where maintenance support requirements cannot be specified quantitatively, qualitative requirements should be used as a supplement. This can for example be specifications of the required training level and workmanship, standard of maintenance personnel or requirements for workshop facilities and tools to be available.

Further information can be found in IEC 706-1.

9 Cooperation between customer and supplier

In order to reduce the number of failures and the down time of the product, it is necessary for the supplier and customer to cooperate during all phases of the product life cycle. This creates various obligations on the part of both customer and supplier; these should be specified.

A formal reliability and maintainability management programme (see IEC 300-1) can help to identify and specify these activities.

Where possible it should be specified that the customer or distributor acknowledge their responsibility to monitor reliability in use and to report field experience (good or bad) to their suppliers.

Annex A (informative)
Examples of reliability, maintainability, maintenance support and availability requirements

A.1 General

Examples of characteristics are given in **A.2** to **A.4**. The values used in the examples are given only to illustrate how they may be stated in the specification. They should not be used as standardized values. Depending on the product, other measures may apply.

NOTE For definitions of the measures see IEC 50(191).

A.2 Reliability requirements

Reliability performance measure	Symbol/abbreviation	Requirement[a]
Mean failure rate	$\bar{\lambda}(t_1,t_2)$	$\leq 27 \cdot 10^{-6}$
Mean time to failure	MTTF	≥ 37 000 h
Mean failure intensity	$\bar{z}(t_1,t_2)$	≤ 1,5/h
Mean operating time between failures	MTBF	≥ 6 000 h
Useful life		≥ 8 years
Reliability	$R(t_1,t_2)$ t_1 = 100 h t_2 = 1 100 h	≥ 0,9

[a] The requirements state the acceptable value (contract value) which should be used to calculate the acceptance criterion for a statistical test.

A.3 Maintainability requirements

Maintainability performance measure	Symbol/abbreviation	Requirement
Mean repair time	MRT	≤ 5 h
Mean active corrective maintenance time		≤ 5,5 h
Mean time to restoration	MTTR	≤ 7 h
Fault coverage		≥ 0,95
Repair coverage		≥ 0,8

A.4 Maintenance support requirements

Maintainance support performance measure	Symbol/abbreviation	Requirement
Mean administrative delay	MAD	2 h
Mean logistic delay	MLD	1 h
Spare shortage probability		0,005

A.5 Availability requirements

Maintainability performance measure	Symbol/abbreviation	Requirement
Mean availability	$\overline{A}(t_1,t_2)$	≥ 0,9999
Mean unavailability	$\overline{U}(t_1,t_2)$	$\leq 10^{-4}$
Mean down time	MDT	1 h

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