

Reliability of systems, equipment and components —

Part 16: Guide to stress screening —

Section 16.1 Repairable items manufactured in lots

ICS 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 Insurance & Risk Management
Association for Project Managers
British Railways Board
British Standards Society
British Telecommunications plc
Chartered Institution of Building Services Engineers
City University
Civil Aviation Authority
Consumer Policy Committee of BSI
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Society of Environmental Engineers
Society of Motor Manufacturers and Traders Limited
United Kingdom Continuous Acquisition Life-cycle Support Industry Council
West Midlands Enterprise Board
Co-opted Members

This British Standard, having been prepared under the direction of the Management Systems Sector Board, was published under the authority of the Standards Board and comes into effect on 15 April 1996

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The following BSI references relate to the work on this standard:

Committee reference DS/1
Draft for comment 90/97177 DC

ISBN 0 580 25467 4

Amendments issued since publication

Amd. No.	Date	Comments
10930 Corrigendum No. 1	April 2001	Indicated by a sideline

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National foreword

This Part of BS 5760 has been prepared under the direction of the Management System Sector Board (MSSB). It is identical with IEC 1163-1:1995, including corrigendum December 1999, *Reliability stress screening — Part 1: Repairable items manufactured in lots*, published by the International Electrotechnical Commission (IEC).

This Part describes methods to optimize stress screening processes for repairable items that are manufactured in lots and have unacceptably low reliability in the early failure period.

BS 5760 provides comprehensive guidance on many aspects of reliability management. Seventeen Parts of this standard have been published and these may be summarized as follows:

Part 0: Introductory guide to reliability. This Part provides guidance for senior management and non-specialists on the importance of reliability and explains how measures to achieve reliability should be integrated with other aspects of project management.

Part 1: Guide to reliability and maintainability programme management. This Part discusses the essential features of a comprehensive reliability and maintainability programme to produce reliable and maintainable products.

Part 2: Guide to the assessment of reliability. This Part explains the purpose and problems of assessing reliability. A range of available assessment techniques is reviewed and the principle advantages and limitations are outlined. Sections are included on the assessment of software reliability, human reliability and one-shot devices. The extension of these techniques to the assessment of availability and to the assessment of reliability of services is considered. This use of a range of statistical distributions to analyse reliability data is described.

Part 3: Guide to reliability practices: examples. This Part contains authentic practical examples illustrating the principles established in BS 5760-1 and BS 5760-2.

Part 4: Guide to specification clauses relating to the achievement and development of reliability in new and existing items. This Part provides detailed guidance on the specification of reliability.

Part 5: Guide to failure modes, effects and criticality analysis (FMEA and FMECA). This Part gives guidance on the application of these techniques.

Part 6: Guide to programmes for reliability growth. This Part describes procedures for exposing and removing weaknesses in hardware and software items in order to achieve acceptable reliability in a product. It explains basic concepts, management and test procedures and describes techniques for analysis and correction of failures.

Part 7: Guide to fault tree analysis. This Part gives guidance on the application of fault tree analysis. This technique may be used to identify factors affecting the reliability, performance and safety characteristics of a system.

Part 9: Guide to the block diagram technique. This Part describes the use of the block diagram technique for modelling and evaluating the reliability of both elementary and more complex systems. The extension of the method to calculate availability is also outlined.

Part 10: Guide to reliability testing.

Section 10.1: General requirements. This Section provides guidance on general principles, procedures and considerations for reliability testing in the laboratory and in the field.

Section 10.2: Design of test cycles. This Section provides a general procedure for design of test cycles, where no applicable preferred test cycles can be found.

Section 10.3: Compliance test procedures for standby-state availability. This Section provides guidance on techniques for testing the availability performance of frequently maintained items under defined conditions.

Section 10.5: Compliance test plans for success ratio. This Section gives procedures for preparing and applying compliance test plans for success ratio or failure ratio. Plans are provided for three main types of test.

NOTE 1 Further Sections of Part 10 based on other Parts of IEC 605 and related IEC standards are planned.

Part 11: Guide to the collection of reliability, maintainability, availability and maintenance support data from the field. This Part provides guidance for the collection of data relating to reliability, maintainability, availability and maintenance support performance of items operating in the field. It deals in general terms with the practical aspects of data collection and presentation and briefly explores the related topics of data analysis and presentation of results.

Part 12: Guide to the presentation of reliability, maintainability and availability predictions. This Part gives guidance on the presentation of quantitative predictions of reliability, maintainability and availability. The items to be included when presenting prediction information are listed and explained with the object of facilitating comparisons between projects and reports.

Part 13: Guide to preferred test conditions for equipment reliability testing.

Section 13.1: Indoor portable equipment: low degree of simulation.

Section 13.2: Equipment for stationary use in weather protected locations: high degree of simulation.

Section 13.3: Equipment for stationary use in partially weather protected locations: low degree of simulation.

Section 13.4: Equipment for portable and non-stationary use: low degree of simulation.

Part 14: Guide to formal design review. This Part provides guidelines for planning and conducting design reviews. Much of the guidance given is widely applicable and relevant to the general conduct of design reviews but it also includes details of the specific contributions to be made by various specialists.

Part 15: Guide to the application of Markov techniques. This Part provides guidance on the application of Markov techniques to dependability analysis. Further information, including advice on the application, benefits and limitations of Markov techniques, is given in BS 5760-2-11.

Part 16: Guide to stress screening.

Section 16.1: Repairable items manufactured in lots. This Section describes methods to optimize stress screening processes for repairable items that are manufactured in lots and have unacceptably low reliability in the early failure period.

Part 17: Reliability growth statistical test and estimation methods. This Part describes the power law reliability growth model. It provides procedures to estimate some or all of the quantities listed in clause 9 of BS 5760-6:1991.

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

NOTE 2 *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 CECC 00804.

Guidance on specific aspects of maintainability is provided in the various Parts of BS 6548 *Maintainability of equipment*.

NOTE 3 This Part of BS 5760 makes reference to BS 4778 *Quality vocabulary*, and in particular to this Part of BS 4778-3.1, which contains definitions relating to concepts applicable to this Part of BS 5760. It is essential that these definitions and concepts should be fully understood if this guide is to be interpreted correctly. For this reason it is recommended that BS 4778 should be read in conjunction with BS 5760.

NOTE 4 BS 4778-3.2 deprecates the use of the terms “failure modes and effects analysis” and “failure modes, effects and criticality analysis”. It favours the use of “fault modes and effects analysis” and “fault modes, effects and criticality analysis”, and these terms are used throughout BS 5760-2. However, the older terms have been retained in BS 5760-5 in order to align it with the current versions of IEC 812.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

Additional information

This standard is a guide and the use of the verbal forms “must” and “shall” in the text does not indicate mandatory requirements.

The term “reliability stress screening” is used in the IEC title and throughout the text of this standard. The Technical Committee considers that the stress screening processes described have a wider application than to improve reliability alone.

IEC 605-4 is currently being revised. The Technical Committee has decided that IEC 300-3-1 and IEC 605-4:1986 are suitable 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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 58, an inside back cover and a back cover.

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Introduction

Quality control and good design are prerequisites for reliability. However, in cases where an item has an unacceptably low reliability in the early failure period, a reliability screening process may be necessary.

An unacceptably low reliability level can be different from one customer to another, or can be based on general market requirements.

Reliability stress screening and reliability growth programmes are both aiming at improvements in the reliability found by the user. However, the two methods are different in principle:

- a reliability growth programme is a development activity, the purpose of which is to improve the inherent reliability performance of the items by effecting changes to the design;
- the purpose of reliability stress screening is to detect and remove flaws; it is part of the production process, and should not be relied upon to reveal inadequacies in design.

Furthermore, the two methods affect the reliability performance differently. This is illustrated in Figure 1. In principle, a reliability screening programme “cuts away” the early failure period (or part thereof), while a reliability growth programme reduces the overall failure rate level. A reliability growth programme may effect the need for a reliability screening programme if the flaws are of such a nature that they can be prevented from being present at all.

The user of this standard should be aware that reliability stress screening does not improve the intrinsic reliability of the items under consideration and, where possible, should be abandoned in favour of reliability growth programmes and/or quality control.

The specific purpose of carrying out a reliability screening process is to detect and remove flaws in hardware items before they reach the customer, or are assembled into higher level products. This means that, in principle, every hardware item under consideration should be included when a reliability screening process is introduced into a production process.

Reliability screening may cover hardware items of different types and at different levels of the manufacturing process. Once the allowable fraction of weak items has been specified, the methods in this standard lead to the most economical screening process for items which are manufactured in lots. This is because not all types of items need to be subjected to a reliability screening process. Only the types of items likely to contain flaws may be included. Furthermore, the extent (stress conditions, duration, etc.) to which these selected item types will be subjected to screening has been minimized.

In reliability stress screening the flaws are precipitated into failures by exposure of the items to a suitable stress, for example environmental stress, operational stress, or a combination of these. Reliability stress screening is often called environmental stress screening or burn-in.

The typical steps in a reliability stress screening process are illustrated in Figure 2.

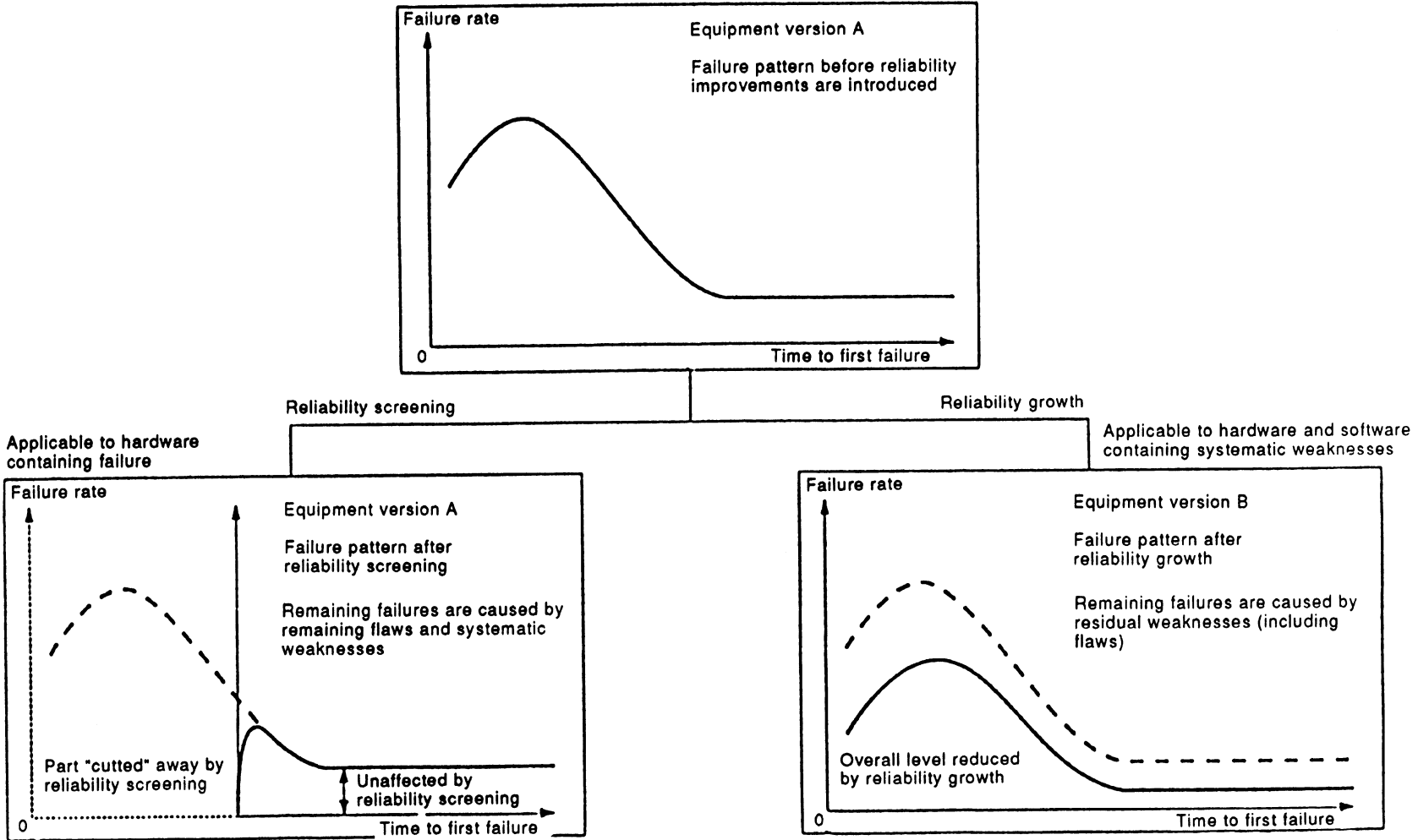
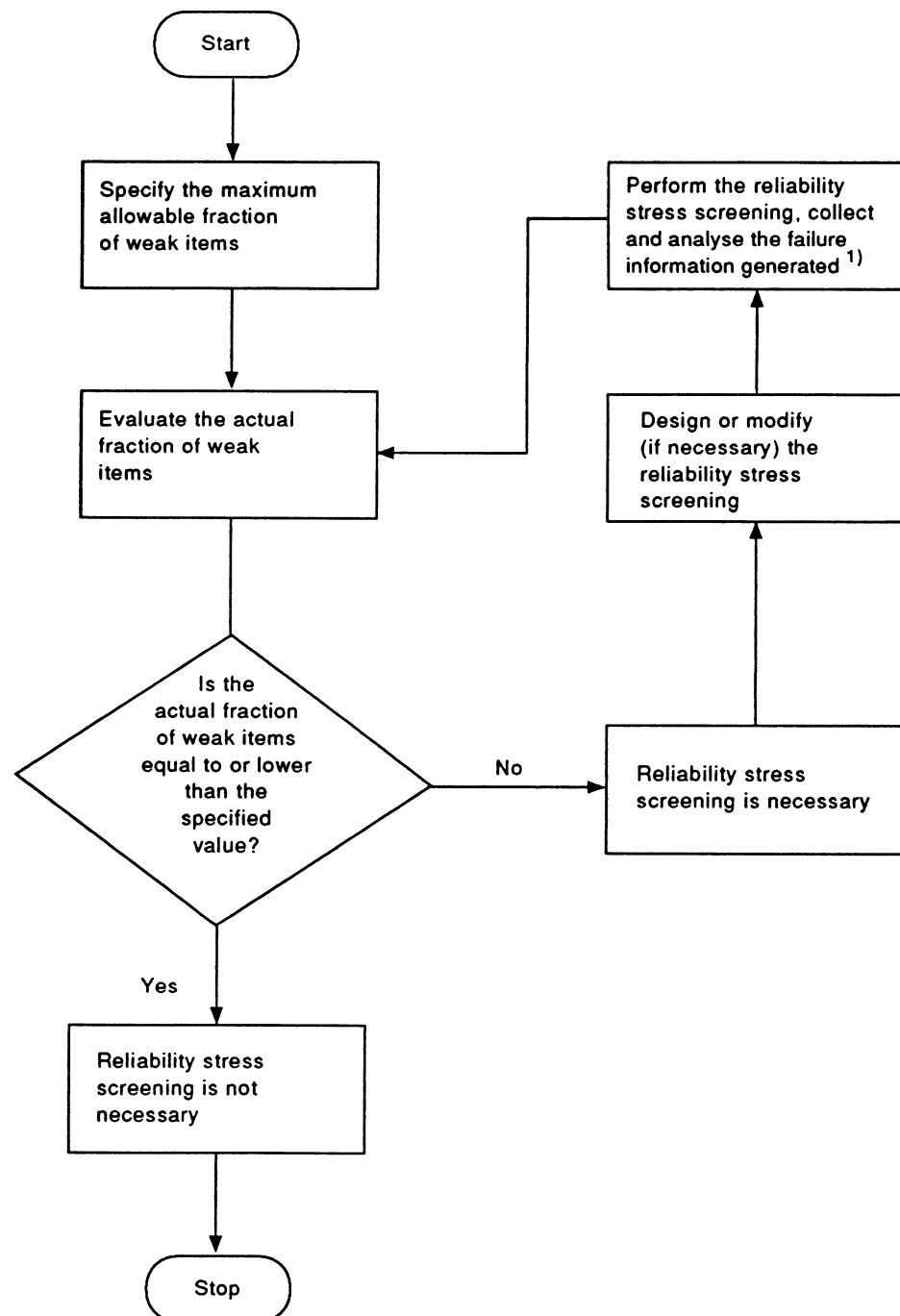


Figure 1 — The conceptual difference between reliability screening and growth



¹⁾ The result of the analysis of the failure causes may be used in a reliability growth programme

Figure 2 — Typical flow for the design and modifications of reliability stress screening processes for repairable items

1 Scope

This International Standard describes particular methods to apply and optimize reliability stress screening processes for lots of repairable hardware items, in cases where the items have an unacceptably low reliability in the early failure period, and when other methods, like reliability growth programmes and quality control techniques, are not applicable. The reasons for using reliability stress screening may be time constraints and/or the very nature of the deficiencies which the reliability stress screening is designed to catch.

The processes apply to any stage of a series production of repairable items (see Figure 3). The methods for setting up a process can be used during production planning, pilot-production, and well-established running production.

A prerequisite for the application of the methods is that a certain level of flaws remaining in the outgoing item can be specified.

The processes described are general processes for reliability stress screening in cases where no specific process is described in a product standard. They are also intended for use by IEC committees in connection with preparation of product standards. A reliability stress screening process could be a part of an overall reliability programme (see the IEC 300 series).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated 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*.

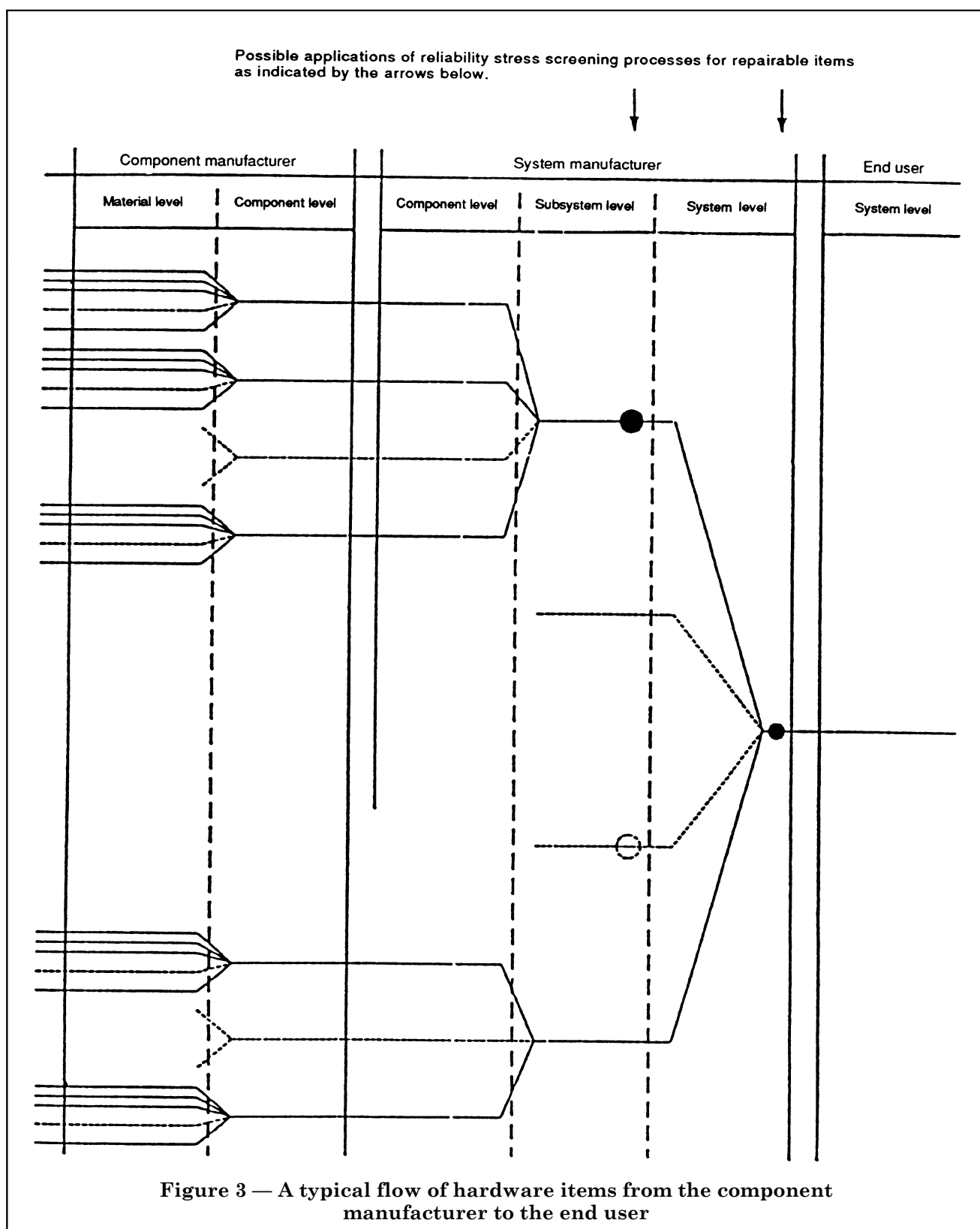
IEC 68(series), *Environmental testing*

IEC 68-2-3:1969, *Environmental testing — Part 2: Tests — Test Ca: Damp heat, steady state*.

IEC 300(series), *Dependability management*.

IEC 605-4:1986, *Equipment reliability testing — Part 4: Procedures for determining point estimates and confidence limits from equipment reliability determination tests*.

IEC 1165:1995, *Application of Markov techniques*.



3 Definitions

Unless otherwise stated, general reliability terms used in this standard comply with IEC 50(191).

Terms of particular importance for reliability stress screening of repairable items are quoted with the IEC 50(191) reference number stated in square brackets. The quotation includes all notes, whether they are relevant for this standard or not. All comments to an IEV term, relevant to reliability stress screening, are stated as “additional notes”.

Other terms defined in this clause are specific to reliability stress screening.

For the purposes of this International Standard, the following definitions apply:

3.1

reliability improvement

a process undertaken with the deliberate intention of improving the reliability performance by eliminating causes of systematic failures and/or by reducing the probability of occurrence of other failures [IEV 191-17-05]

ADDITIONAL NOTE Reliability stress screening reduces the probability of occurrence of other failures. The systematic failures are principally catered for by a reliability growth programme, but some may appear during reliability screening.

3.2

reliability screening

a process of detection of flaws and removal or repair of weak items for the purpose of reaching rapidly the reliability level expected during the useful life

NOTE 1 IEC(191) defines in clause **17-02** the term “burn-in”. This term, however, is used by many manufacturers to describe a so-called “soak test”, which is only one of many possible ways of screening. Furthermore, “burn-in” may include ageing, the purpose of which is to stabilize parameters, and in many cases where no failures occur.

NOTE 2 IEC(191) defines in clause **14-09** the term “screening test”. This term, however, is defined too broadly to be applicable in the present context, because it encompasses screening for any type of non-conformities. Furthermore, reliability screening is a process, not a test.

3.3

reliability stress screening

a reliability screening process using environmental and/or operational stresses as means of detecting flaws by precipitating them as detectable failures

NOTE The reliability stress screening is designed with the intention of precipitating flaws into detectable failures. An ageing process designed with the intention of stabilizing parameters is not a reliability screening process, and therefore outside the scope of this standard.

3.4

item

any part, component, device, subsystem, functional unit, equipment, or system that can be individually considered [IEV 191-01-01]

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

NOTE 2 In French the term “entité” is preferred to the term “dispositif” due to its more general meaning. The term “dispositif” is also the common equivalent for the English term “device”.

NOTE 3 In French the term “individu” is used mainly in statistics.

NOTE 4 A number of items, for example a population of items or a sample, may itself be considered as an item.

ADDITIONAL NOTE In the context of reliability screening, only the hardware part of an item is relevant. Current examples are electronic components, assemblies, equipment, and hardware parts of systems.

3.5

weak item

an item which has a high probability of failing early in life, due to a flaw

3.6

component

any single item which is not intended to be repaired

3.7**component class**

a group of components characterized by having one or more of the following features in common:

- technology;
- type;
- manufacturer;
- batch.

3.8**rogue component class**

a component class, which is likely to contain components with inherent and/or induced flaws

NOTE The lifetime distribution of a rogue component class can, for the purpose of reliability stress screening, be approximated with a bimodal distribution. This means that the individual component may be either weak or strong.

3.9**assembly**

any composite item which is intended to be repaired

3.10**relevant failure**

a failure that should be included in interpreting test, or operational results, or in calculating the value of a reliability performance measure [IEV 191-04-13]

NOTE The criteria for inclusion should be stated.

ADDITIONAL NOTE The criterion for inclusion here is that the failure is caused by either an induced or an inherent flaw.

3.11**weakness**

any imperfection (known or unknown) in an item, capable of causing one or more weakness failures

NOTE Each type of weakness is assumed to be statistically independent of all other such types.

3.12**weakness failure**

a failure due to weakness in the item itself when subjected to stress within the stated capability of the item [IEV 191-04-06]

NOTE A weakness may be either inherent or induced

3.13**flaw**

a weakness in hardware, which gives rise to early weakness failures

NOTE A flaw is localized to a component, or to an interaction between components, with characteristics close to the margins of the design requirements.

3.14**inherent flaw**

a flaw in an item related to its technology and manufacturing process

3.15**induced flaw**

a flaw in an item related to assembling, testing, handling, or other manipulation of the item after it has been manufactured

NOTE The induction may take place at the component manufacturer's plant, during transportation or at the system manufacturer's plant.

3.16**early failure period**

that early period, if any, in the life of an item, beginning at a given instant of time and during which the instantaneous failure intensity for a repaired item, or the instantaneous failure rate for a non-repaired item, is considerably higher than that of the subsequent period [IEV 191-10-07]

ADDITIONAL NOTE The early failure period is the period where the weak items fail.

4 Symbols

In this standard, the following symbols are used:

m_{F1}	the mean time to failure for the weak components in the rogue component classes lumped together
m_{Fs}	the mean time to first failure for the weak items among the items under consideration
N	the sum of the numbers of components in the rogue component classes
p_B	the acceptable fraction of weak items remaining after reliability stress screening
p_c	the fraction of weak components in the rogue component classes lumped together
p_s	the fraction of weak items before reliability stress screening
T_B	mean duration of reliability screening per item
T_M	the failure-free period an item has to survive before submission to the next production step or to the customer

5 General description

5.1 The reliability stress screening principle

The general principle of reliability stress screening is shown on the flow diagram in Figure 4. According to this principle, an item has to survive a so-called “failure-free period”, T_M , before it is released to the next step of production, or to the customer. Other screening principles may be possible, but are not covered by this standard.

The flow diagram shows three alternatives in connection with the stress conditioning.

- Alternative A shows two function checks, one before and one after the stress conditioning.
- Alternative B shows performance monitoring at discrete points in time with time intervals, preferably selected according to a logarithmic scale, so that the closest monitoring takes place in the beginning of the stress conditioning.
- Alternative C shows continuous monitoring during the entire stress conditioning. This alternative is preferable, because of
 - time saving;
 - detection of intermittent failures and of failures present only during the action of the stress;
 - avoiding of stressing after a failure.

The performance monitoring is of particular importance during pilot-production reliability stress screening. During mature production, reliability stress screening the performance monitoring under stress conditioning may be deleted, according to the circumstances. However, the two function checks, one before and one after the stress conditioning period, can never be omitted. Items should not be put directly under stress conditioning without the initial function check.

The extent and the details of the functional checking before, during and after the stress conditioning depend strongly on the nature and intended function of the items in question. This standard contains no guidance in that respect. The procedures described hereafter, however, presume that the function checks are efficient in evidencing failures.

The further details of the screening procedures depend on the time phase from product design to mature production. Three stages are considered:

- planning of reliability stress screening;
- pilot-production reliability stress screening;
- mature production reliability stress screening.

5.2 Failure categories

The items failing during a reliability stress screening shall be carefully examined in order to establish the failure modes, mechanisms, and/or causes.

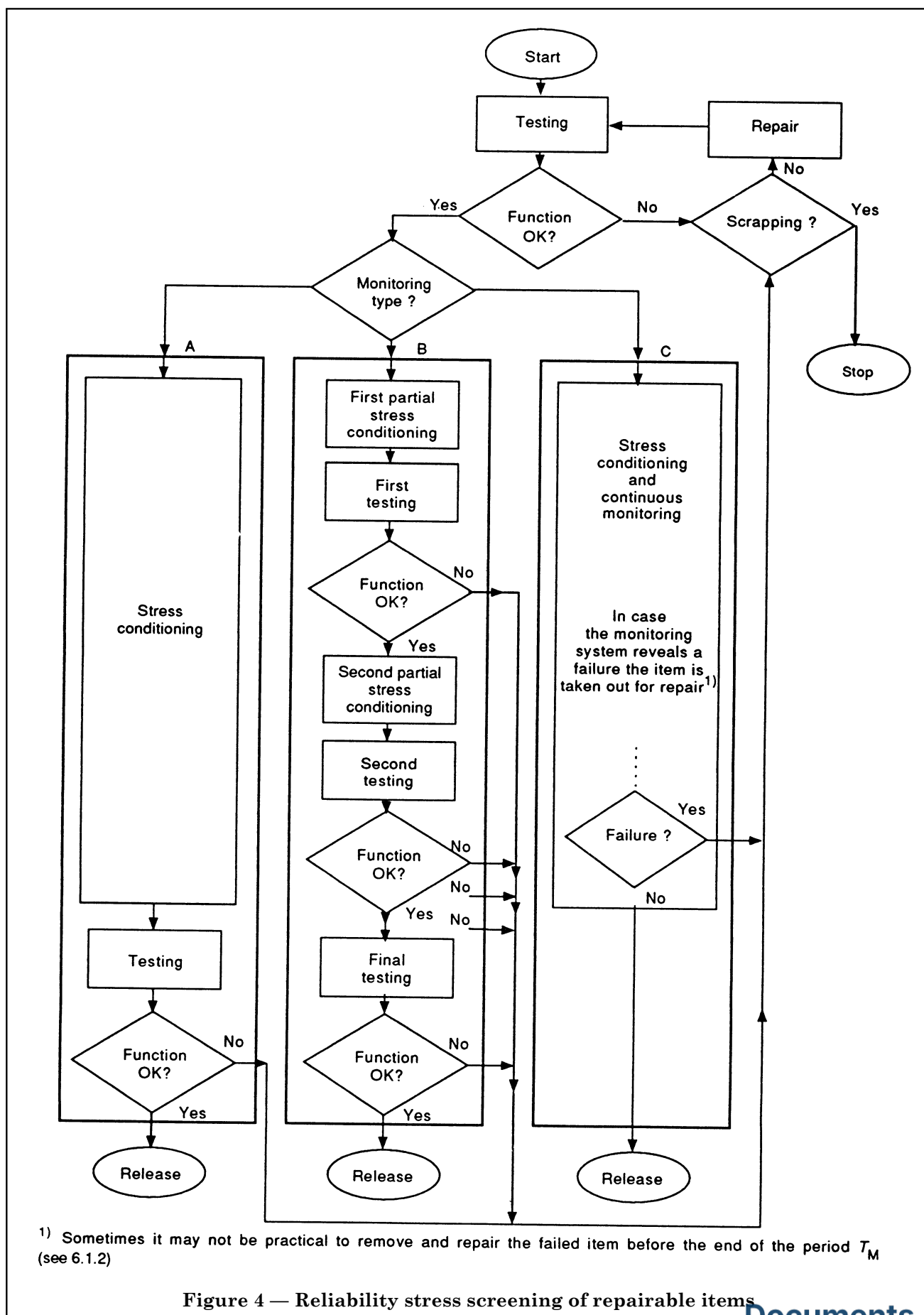


Figure 4 — Reliability stress screening of repairable items

For the purpose of defining corrective actions, the failure shall be classified in the following three categories, based on an assessment of the above-mentioned examination result:

- a) inadequate product design;
- b) inherent flaws;
- c) induced flaws.

Referring to Figure 5, the classification may differ depending on whether the assessment takes place at the component manufacturer or at the assembly manufacturer.

Inadequate component design and flaws induced into the component by the component manufacturer become inherent flaws at the assembly manufacturer.

In most cases, only the induced and the inherent flaws may be weeded out by the screening process. However, in some cases a screening process may be applied to cater for marginal design problems, and/or for processes which are difficult to control.

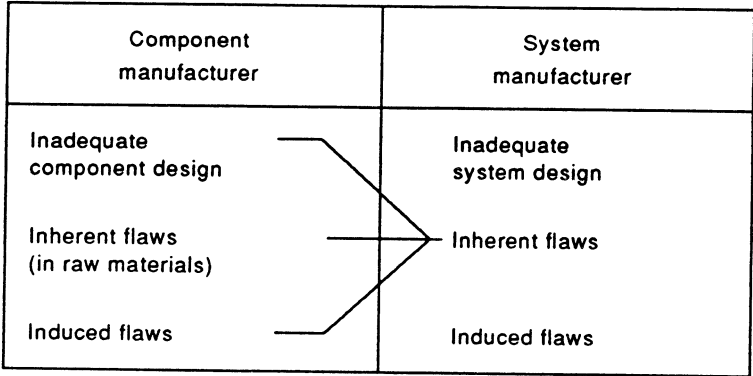


Figure 5 — Dependency of categories of failures

5.3 Time of occurrence of failures

The time of occurrence of failures shall be recorded and evaluated. This is a vital part of the reliability stress screening process, making it possible to permanently monitor it to ensure that the failure data used for the design of the process are still relevant.

6 Planning

6.1 Stress conditioning

The stress conditioning is composed of the screening duration and the stress conditions as illustrated in Figure 6. The conditions are defined by the levels, cycles, and types.

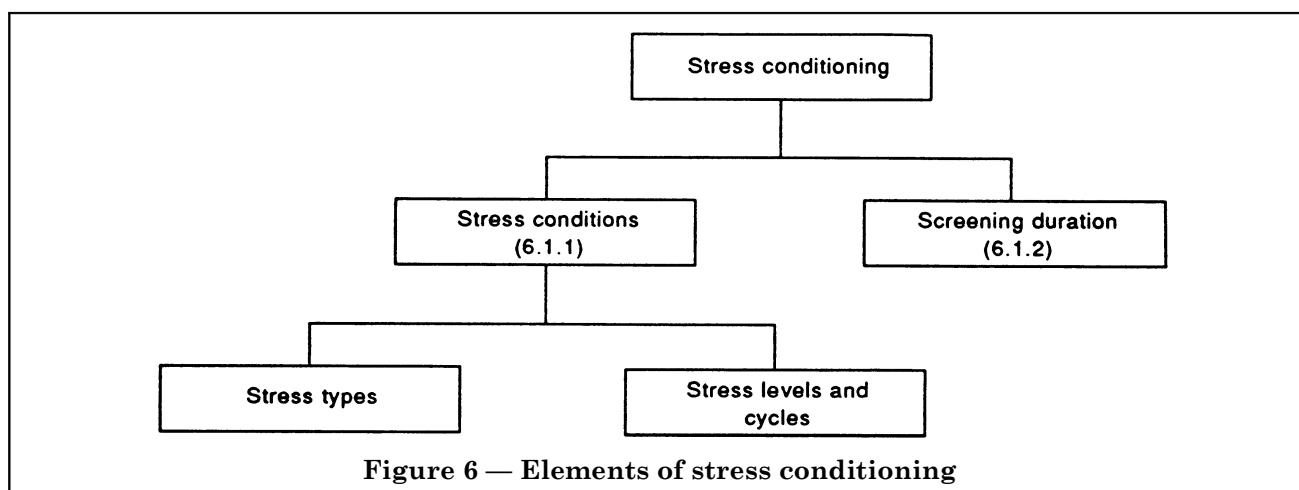
6.1.1 Stress conditions

Preferably, the stress conditions should be tailored for the items under consideration. They shall aim at excitation of flaw-related failure mechanisms likely to create failures in the field, without altering the characteristics of sound items or sound parts of an item.

The procedure for the choice of stress condition is as follows.

- 1) Consider the expected field conditions, that is the operational and environmental stresses in the field, and list as far as possible the weaknesses likely to give early failures under these conditions, taking into account the design and the manufacturing process of the item.
- 2) Group the weaknesses listed into three groups:

- a) Weaknesses which cost-effectively can be removed by design or process modifications. Reliability stress screening should not be applied to remove weaknesses of this kind.
- b) Weaknesses which cost-effectively can be removed by some kind of inspection during production. These cannot be taken care of by reliability stress screening. Visual inspection or reliability indicator screening should be used.



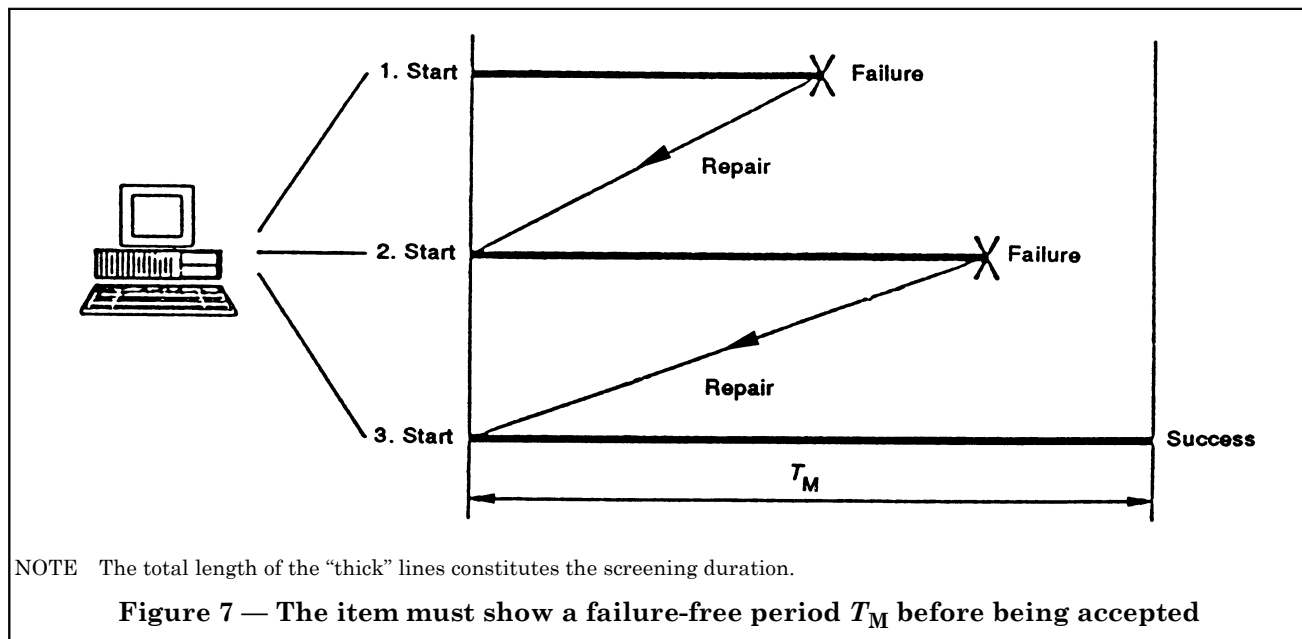
- c) The remaining weaknesses constitute the flaws that can be removed by reliability stress screening.
- 3) Consider the flaws and evaluate the environmental and/or operational stresses which are most likely to develop these flaws into failures. Guidance concerning the effect of different stress conditions can be found in Annex B to Annex E.
 - 4) Select among the stresses identified the most efficient stress condition/conditions, including their sequence and/or combinations. The stresses selected may not be directly related to the field conditions. Guidance concerning preferred stress conditions and their efficiency can be found in Annex A.
 - 5) For each stress condition, evaluate the maximum stress level which can be used without overstressing any component in the item under consideration. This will normally mean that the stress should be within the specified operating limits of the item, rather than the constituent component.

6.1.2 Screening duration

The screening duration is the accumulated relevant time during which an item is exposed to the screening stress conditions. It is a stochastic variable, which depends on how many times the item has to be repaired before it has survived a predetermined failure-free period (see Figure 7).

For an item without flaws, the screening duration is likely to be one failure-free period.

For an item with many flaws, or susceptible to induction of flaws (for example during repair), the screening duration will be generally longer. For technical and/or economical reasons, it may be necessary to limit the maximum permissible number of repairs. Items exceeding that number shall be scrapped (see Figure 4). A method for the calculation of the average screening duration appears in Annex G.



6.2 Evaluation of the failure-free period T_M

6.2.1 Collection of information

The necessary information for the determination of the failure-free period, T_M is:

- the fraction of weak components in each of the rogue component classes;
- the mean time to failure for the weak components in each of the rogue component classes;
- the sum of the numbers, N , of components in the rogue component classes;
- the acceptable fraction, p_B , of weak items that can be submitted to the next level of production, or to the customer.

The first step is to identify the rogue component classes, which for a good design should be few. Previous experience from reliability stress screening and/or field failure reports on systems, for which similar assembling and component technology has been applied, can be used.

For the determination of the fraction of weak components and the mean times to failures of the weak components in the rogue component classes, it is necessary to make some educated guesses, which also can be based on previous experience as above. The values of the mean times to failures should be assessed for the proposed stress screening conditions. Very high degree of accuracy is not necessary in the planning procedure, as corrections can be made after pilot-production and/or during the production.

The value of N is accurately calculated by counting the number of components in the rogue component classes in the assembly.

Finally, the value of p_B is a decision which should be based on market requirements for the customer's satisfaction.

For reliability stress screening on several production levels, the value of p_B for the final product should be decided first. The p_B values for the intermediate production levels should then be determined in order to achieve the final value.

6.2.2 Determination of the failure-free period T_M

The model for screening assumes that the lifetime distribution for the weak items is exponential and that the strong items in practical terms have infinite lifetimes. This assumption is useable for engineering purposes.

The procedure for the determination of the failure-free period, T_M , consists of six steps.

STEP 1: The various rogue component classes are lumped together as one “anonymous” component class.

- The early failure fraction, p_c , is set equal to the largest of the values evaluated under **6.2.1**.
- The mean time to failure, m_{F1} , for the weak components in this class is set equal to the largest of the values evaluated under **6.2.1**.

STEP 2: Compute the expected fraction, p_s , of weak items at time zero before screening, using the following formula:

$$p_s = 1 - (1 - p_c)^N \quad (1)$$

where

p_c is the early failure fraction of the “anonymous” rogue component class, and

N is the total number of components in the “anonymous” rogue component class in the item.

STEP 3: Compare p_B with the value of p_s determined in step 2.

If $p_B > p_s$ screening is not necessary.

If $p_B < p_s$ screening is necessary. Then proceed to step 4.

STEP 4: Look up the time graph in **6.3** that corresponds to the early failure fraction, p_c (step 1). If p_c is not on the graphs, then choose the nearest value and recalculate the N_n values on the graphs by:

$$N_n = N' \frac{p'_c}{p_c} \quad (2)$$

where

N' and P'_c are the printed values on the actual time graph, and

N_n is the recalculated N values corresponding to the present value of P_c .

STEP 5: Find the value of p_B on the vertical scale on the selected time graph and draw a horizontal line to intersect the curve for the specific value of N , the total number of components in the “anonymous” rogue component class (see **6.2.1** for the definition of N and p_B).

STEP 6: At the point of intersection, read off the value on the horizontal scale. This is the failure-free period, normalized with respect to m_{F1} (step 1). Multiply this value with m_{F1} to find the failure-free period T_M .

6.3 Time graphs for determination of the failure-free period

Figure 8a to Figure 8h give the normalized failure-free period T_M as function of the fraction p_B of weak items remaining after reliability stress screening and as a function of the total number, N , of components in the “anonymous” rogue components class.

7 Pilot-production screening

The reliability stress screening is carried out as planned according to clause **5** for all items manufactured during the pilot-production phase.

Careful monitoring (preferably of type C in Figure 4) is very important here in order to obtain as much information as possible.

7.1 Collection of information

A suitable subset of items are marked for the collection of further information through a prolonged screening. As a rule of thumb, 30 items monitored for a time of $7 T_M$ should provide enough information for a decision for a possible revision.

The information collected for the whole pilot production lot, as well as the subset, shall be:

- the type and cause of failures;
- the time to first failure of the items under consideration.

7.2 Evaluation of information

Consider whether the failures are relevant. If not, reconsider the selected stress condition/conditions (stress types, levels and cycles).

If the failures are relevant, make a Weibull plot of the times to first failure (see Annex F and IEC 605-4). Evaluate the shape of the Weibull plot, and note whether the curve is levelling off after the first rise. If not, reconsider the stress conditioning (stress conditions and duration).

NOTE The Weibull plotting technique is selected, because it is easy to use and caters for the exponential case as well; other plotting techniques may be used.

If a levelling off can be identified, determine the number N of components in the “anonymous” rogue component class that the screening has revealed.

Derive then from the Weibull plot the fraction of weak items (the “horizontal” part of the Weibull curve). This is the value p_s (the fraction of weak items before screening).

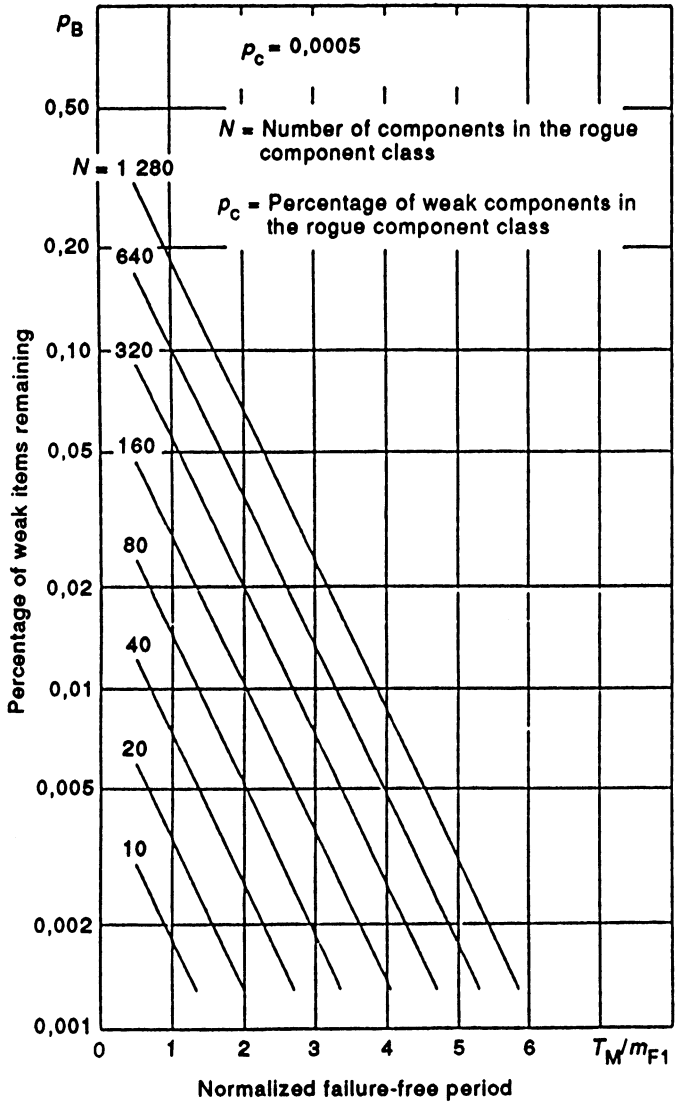


Figure 8a

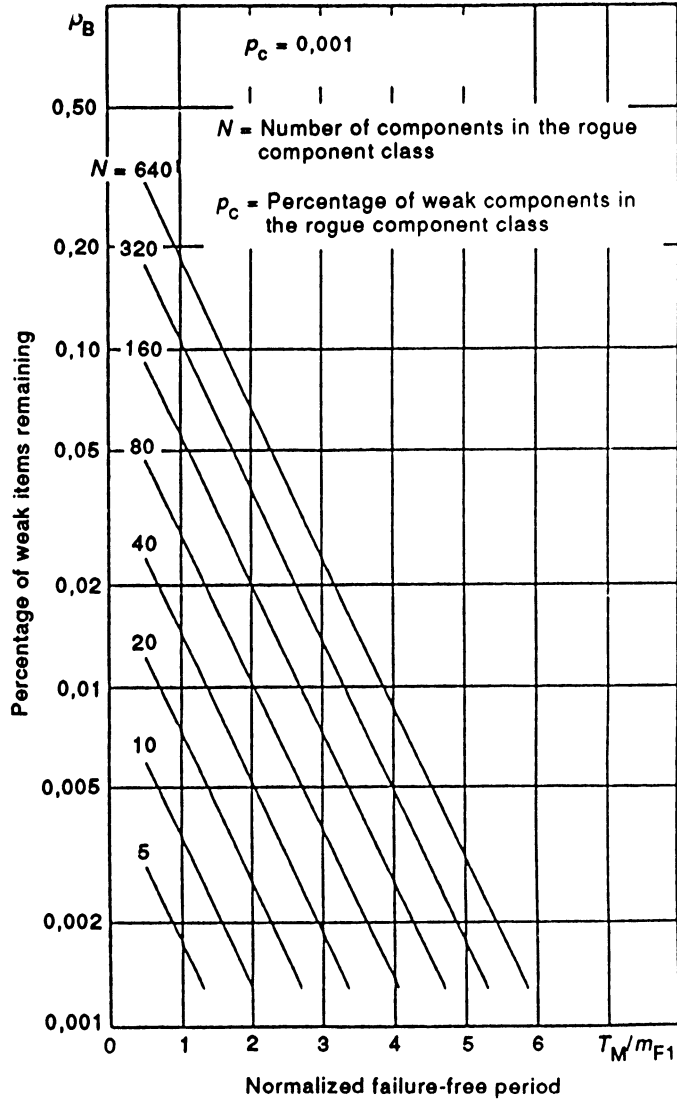


Figure 8b

Figure 8 — Time graphs for determination of the failure-free period

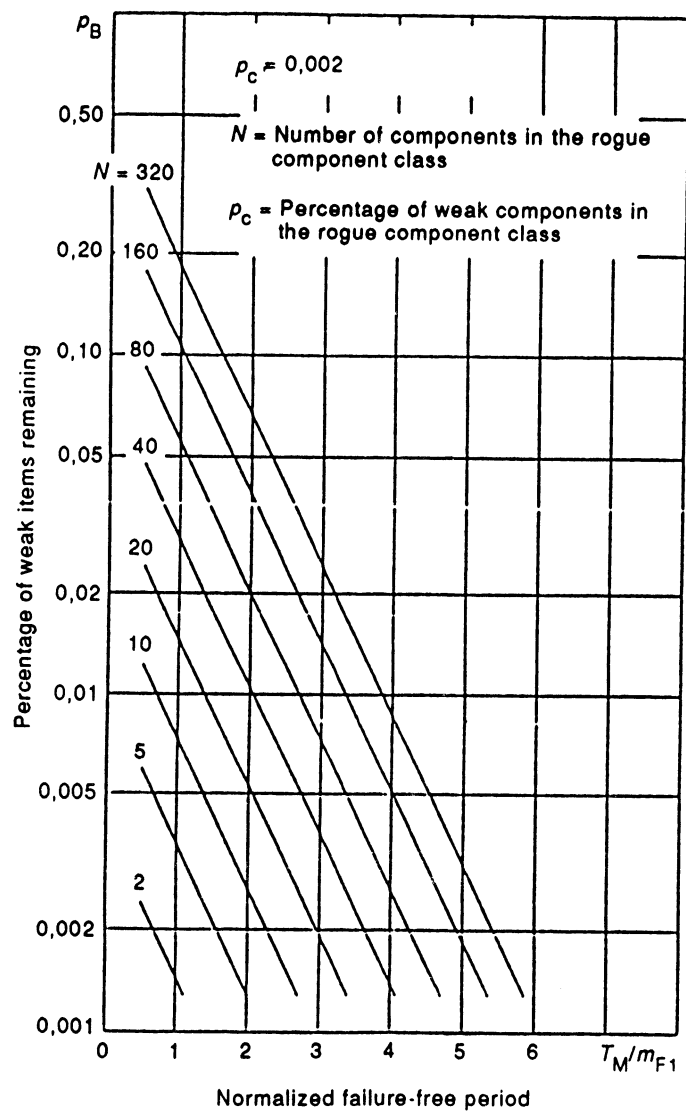


Figure 8c

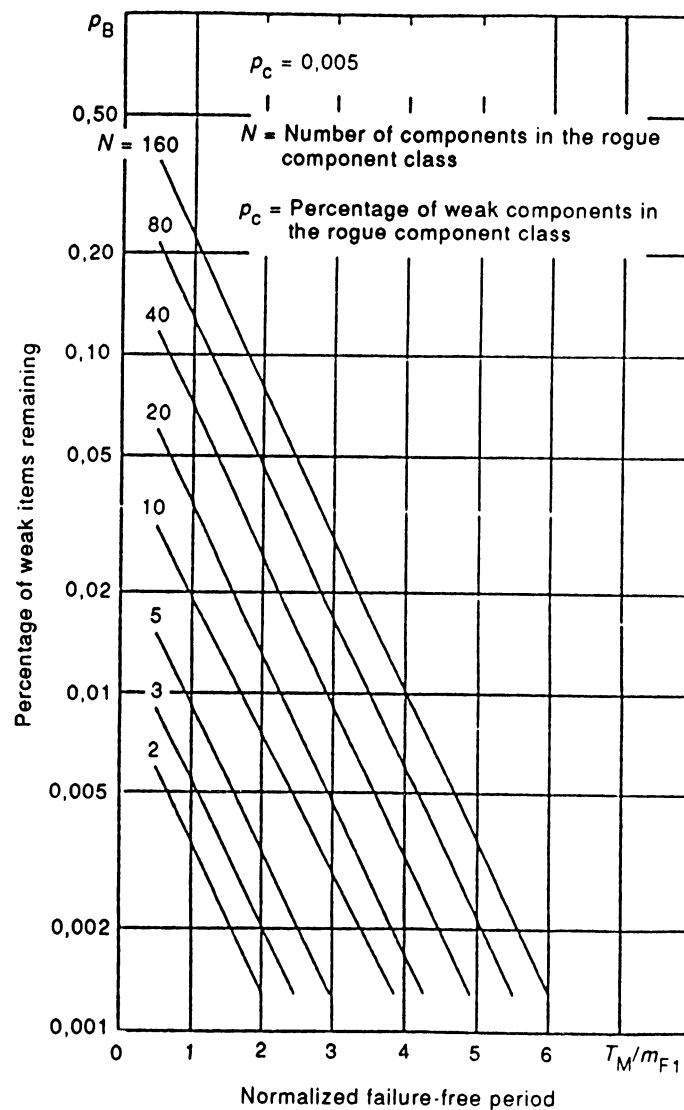


Figure 8d

Figure 8 — Time graphs for determination of the failure-free period (continued)