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Second edition
2004-07

Dependability management –

Part 3-3: Application guide – Life cycle costing

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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DEPENDABILITY MANAGEMENT –

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FOREWORD

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International Standard IEC 60300-3-3 has been prepared by IEC technical committee 56: Dependability.

This second edition cancels and replaces the first edition published in 1996, and constitutes a full technical revision.

This edition expands upon the technical guidance in response to requests from practitioners. The examples in particular have been enhanced.

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

FDIS	Report on voting
56/942/FDIS	56/962/RVD

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

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

IEC 60300 consists of the following parts, under the general title *Dependability management:*

Part 1: Dependability management systems

Part 2: Dependability programme elements and tasks

Part 3: Application guide

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

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- withdrawn;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

A bilingual version may be issued at a later date.

INTRODUCTION

Products today are required to be reliable. They have to perform their functions safely with no undue impact on the environment and be easily maintainable throughout their useful lives. The decision to purchase is not only influenced by the product's initial cost (acquisition cost) but also by the product's expected operating and maintenance cost over its life (ownership cost) and disposal cost. In order to achieve customer satisfaction, the challenge for suppliers is to design products that meet requirements and are reliable and cost competitive by optimizing acquisition, ownership and disposal costs. This optimization process should ideally start at the product's inception and should be expanded to take into account all the costs that will be incurred throughout its lifetime. All decisions made concerning a product's design and manufacture may affect its performance, safety, reliability, maintainability, maintenance support requirements, etc., and ultimately determine its price and ownership and disposal costs.

Life cycle costing is the process of economic analysis to assess the total cost of acquisition, ownership and disposal of a product. This analysis provides important inputs in the decision-making process in the product design, development, use and disposal. Product suppliers can optimize their designs by evaluation of alternatives and by performing trade-off studies. They can evaluate various operating, maintenance and disposal strategies (to assist product users) to optimize life cycle cost (LCC). Life cycle costing can also be effectively applied to evaluate the costs associated with a specific activity, for example, the effects of different maintenance concepts/approaches, to cover a specific part of a product, or to cover only selected phase or phases of a product’s life cycle.

Life cycle costing is most effectively applied in the product’s early design phase to optimize the basic design approach. However, it should also be updated and used during the subsequent phases of the life cycle to identify areas of significant cost uncertainty and risk.

The necessity for formal application of the life cycle costing process to a product will normally depend on contractual requirements. However, life cycle costing provides a useful input to any design decision-making process. Therefore, it should be integrated with the design process, to the extent feasible, to optimize product characteristics and costs.

DEPENDABILITY MANAGEMENT –

Part 3-3: Application guide – Life cycle costing

1 Scope

This part of IEC 60300 provides a general introduction to the concept of life cycle costing and covers all applications. Although the life cycle costs consist of many contributing elements, this standard particularly highlights the costs associated with dependability of the product.

This standard is intended for general application by both customers (users) and suppliers of products. It explains the purpose and value of life cycle costing and outlines the general approaches involved. It also identifies typical life cycle cost elements to facilitate project and programme planning.

General guidance is provided for conducting a life cycle cost analysis, including life cycle cost model development. Illustrative examples are provided to explain the concepts.

2 Normative references

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

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

IEC 60300-3-12, *Dependability management – Part 3-12: Application guide – Integrated logistic support*

IEC 61703, *Mathematical expressions for reliability, maintainability and maintenance support terms*

IEC 62198, *Project risk management – Application guidelines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-191 and IEC 61703, together with the following definitions, apply.

3.1
life cycle
time interval between a product's conception and its disposal

3.2
life cycle costing
process of economic analysis to assess the life cycle cost of a product over its life cycle or a portion thereof

3.3
life cycle cost
LCC
cumulative cost of a product over its life cycle

3.4
base date
fixed point in time set as the common cost reference

4 Life cycle costing

4.1 Objectives of life cycle costing

Life cycle costing is the process of economic analysis to assess the total cost of acquisition, ownership and disposal of a product. It can be applied to the whole life cycle of a product or to parts or combinations of different life cycle phases.

The primary objective of life cycle costing is to provide input to decision making in any or all phases of a product's life cycle.

An important objective in the preparation of LCC models is to identify costs that may have a major impact on the LCC or may be of special interest for that specific application. Equally important is to identify costs that may only influence the LCC to a very small extent.

The more common types of decisions to which the life cycle costing process provides input include, for example:

– evaluation and comparison of alternative design approaches and disposal options technologies;
– assessment of economic viability of projects/products;
– identification of cost contributors and cost effective improvements;
– evaluation and comparison of alternative strategies for product use, operation, test, inspection, maintenance, etc.;
– evaluation and comparison of different approaches for replacement, rehabilitation/life extension or retirement of ageing facilities;
– allocation of available funds among the competing priorities for product development/ improvement;
– assessment of product assurance criteria through verification tests and its trade-off;
– long-term financial planning.

Life cycle costing can be used to provide input to integrated logistic support analysis. See IEC 60300-3-12 for detailed information on integrated logistic support analysis.

4.2 Product life cycle phases and LCC

Fundamental to the concept of life cycle costing is a basic understanding of a product life cycle and the activities that are performed during these phases. Also essential is an understanding of the relationship of these activities to the product performance, safety, reliability, maintainability and other characteristics contributing to life cycle costs.

There are six major life cycle phases of a product as follows:

a) concept and definition;
b) design and development;
c) manufacturing;

d) installation;

e) operation and maintenance;

f) disposal.

The appropriate life cycle phases, or parts or combinations of these phases, should be selected to suit the special needs of each specific analysis. In a general way, the total costs incurred during the above phases can also be divided into acquisition cost, ownership cost and disposal cost.

$$LCC = Cost_{acquisition} + Cost_{ownership} + Cost_{disposal}$$

Acquisition costs are generally visible, and can be readily evaluated before the acquisition decision is made and may or may not include installation cost.

The ownership costs, which are often a major component of LCC, in many cases, exceed acquisition costs and are not readily visible. These costs are difficult to predict and may also include the cost associated with installation.

Disposal costs may represent a significant proportion of total LCC. Legislation may require activities during the disposal phase that for major projects, e.g. nuclear power stations, involve a significant expenditure.

Figure 1 shows the life cycle phases of a product, together with some of the topics that should be addressed by a life cycle costing study.

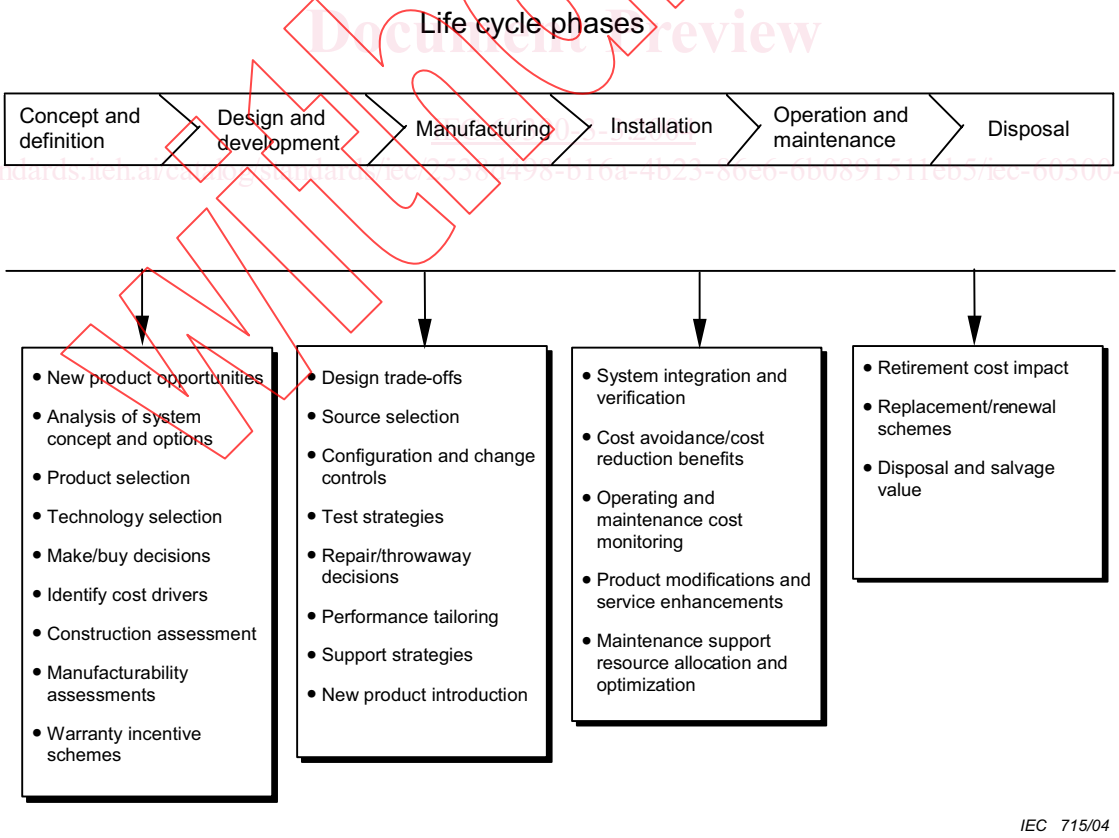


Figure 1 – Sample applications of life cycle costing

4.3 Timing of LCC analysis

Early identification of acquisition, ownership and disposal costs enables the decision-maker to balance dependability factors against life cycle costs. Decisions made early in a product's life cycle have a much greater influence on LCC than those made later in a product's life cycle. Experience has shown that by the end of the concept and definition phases, more than half of a product's LCC may be committed by decisions. The opportunity to perform trade-offs becomes increasingly limited as the product advances in its life cycle.

Life cycle costing may address the whole life cycle of a product or only part of it. The life cycle costing should be tailored to suit a particular product/project in order to obtain the maximum benefit from the analysis effort.

4.4 Dependability and LCC relationship

4.4.1 General

Dependability of a product is the collective term used to describe the product's availability performance and its influencing factors, i.e. reliability performance, maintainability performance and maintenance support performance. Performance in all these areas can have a significant impact on the LCC. Higher initial costs may result in improved reliability and/or maintainability, and thus improved availability with resultant lower operating and maintenance costs.

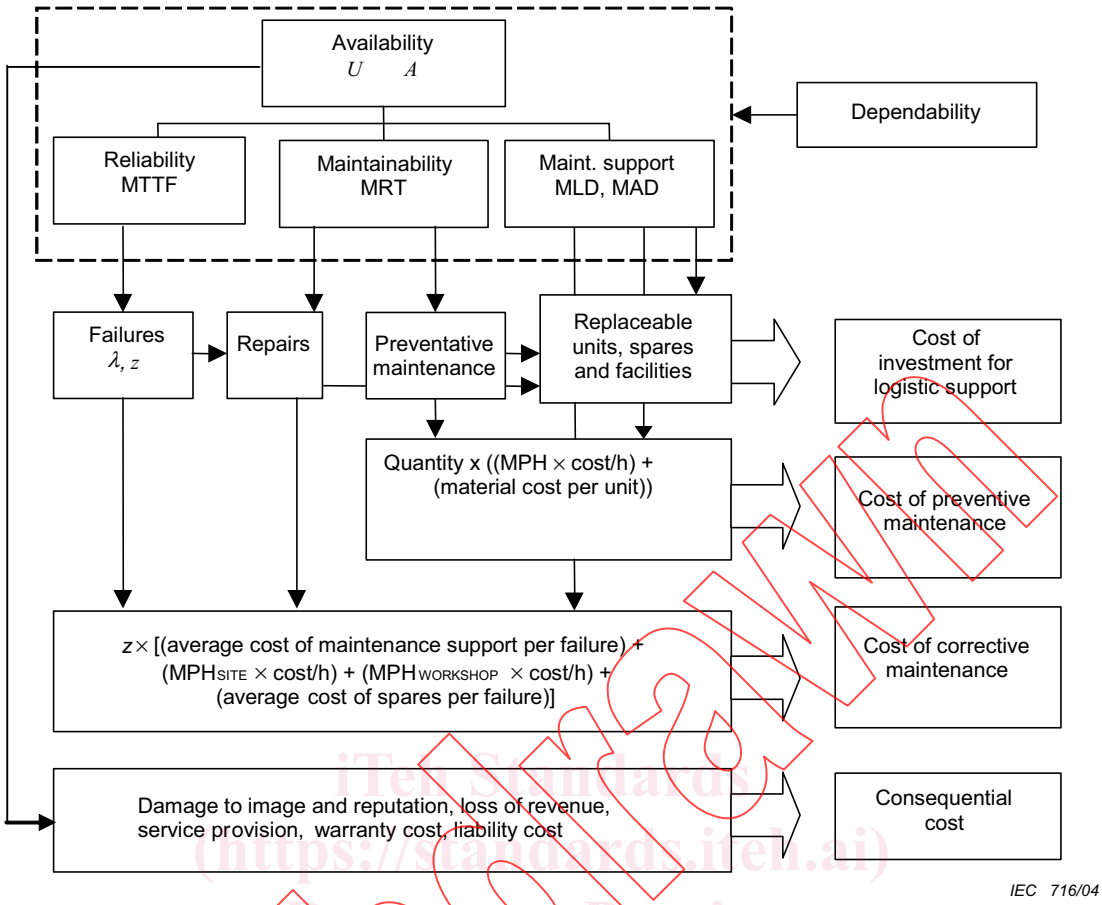
Dependability considerations should be an integral part of the design process and LCC evaluations. These considerations should be critically reviewed when preparing product specifications, and be continually evaluated throughout the design phases in order to optimize product design and the life cycle cost.

4.4.2 Dependability related costs

Costs associated with dependability elements may include the following, as appropriate:

– system recovery cost including corrective maintenance cost;
– preventive maintenance cost;
– consequential cost.

Figure 2 highlights some dependability elements translated into operation and maintenance costs.



Symbols and abbreviations apply in accordance with IEC 60050(191).

Figure 2 – Typical relationship between dependability and LCC for the operation and maintenance phase

4.4.3 Consequential costs

4.4.3.1 General

When a product or service becomes unavailable, a series of consequential costs may be incurred. These costs may include:

– warranty cost;
– liability cost;
– cost due to loss of revenue;
– costs for providing an alternative service.

In addition, further consequential costs should be identified by applying risk analysis techniques to determine costs of adverse impacts on the company's:

– image,
– reputation,
– prestige,

which in turn may result in loss of clients.

Costs of recovering from, or mitigating against these risks should be included in consequential costs.

In most cases, these costs are difficult to assess, but sometimes it is possible to quantify them. For example, these costs may be estimated based on publicity campaign costs and costs of marketing efforts or compensations in order to retain the clients. Where applicable, these costs should be accounted for.

The unavailability of a product can significantly affect its LCC. Therefore, the availability performance of a product and associated life cycle cost needs to be optimized. With increasing reliability (all other factors held constant), the acquisition costs will generally increase but maintenance and support costs will decrease. The LCC is optimized when the incremental increase in acquisition costs due to reliability improvements equals the incremental savings in maintenance and support costs, and in consequential costs. At a certain point, an optimum product reliability, which corresponds to the lowest life cycle cost, is achieved.

It should be noted that the results of LCC calculations might not match the actual/observed costs. This is because there are many influencing random factors, such as environmental conditions and human errors during operation, which cannot be accurately modelled in the calculations.

Environmental issues, as well as traditional factors such as cost and time, have to be considered in LCC calculations. Therefore, methods have to be used to evaluate and rank environmental consequences of different activities. These evaluations can provide the bases for environmental planning and integrating environmental issues with decision making.

4.4.3.2 Warranty costs

Warranties provide protection to the customers, insulating them from the cost of correcting product failures, in particular during the early stages of product operations. The cost of warranties is usually borne by the suppliers, and may be affected by reliability, maintainability and maintenance support characteristics of the product. Suppliers can exercise significant control over these characteristics during design and development, and manufacturing phases thus influencing the warranty costs.

Warranties usually apply for a limited period of time, and a number of conditions generally apply. Warranties rarely include protection against consequential costs incurred by the customer due to product unavailability.

Warranties may be supplemented or replaced by service contracts whereby the supplier performs, in addition to any arrangements made by the customer, all preventive and corrective maintenance for a fixed period of time that can be renewed for any period up to the whole product lifetime. In the latter case, the suppliers are motivated to build an optimum level of reliability and maintainability into their product, usually at higher acquisition costs.

4.4.3.3 Liability costs

A liability will arise where, for example, a supplier fails to comply with his legal obligations. The cost of compensating for a breach of the law needs to be considered as part of the LCC. This is especially important in the case of products that have a high potential to cause human injury and/or environmental damage. Liability costs are also important for new products for which risks involved may not be fully apparent and/or well understood. Where required, a risk analysis, together with past experience and expert judgement, may be used to provide an estimate of these costs. For guidance on risk analysis, see IEC 62198.