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Title:
IEC 62430 Ed.1:
Environmentally Conscious Design for electrical and electronic products and systems

Introductory note

The IEC 62430 has been drafted under the WG2 "Environmentally Conscious Design (ECD) for Electrical and Electronic Products and Systems" of TC111. We held the 1st meeting at Tokyo (June 2005), 2nd at Milan (Oct 2005), 3rd at Bangkok (Jan 2006), 4th at Redmond (June 2006), 5th at Shanghai (December 2006), and 6th at Munich (March 2007) with about 50 experts participating from 15 National Committees and 2 liaison organizations. Within and between those meetings, the experts worked hard by sharing their roles to draft each part of the text and collaborate with each other to improve the whole draft.

August 2006, TC111 issued the 1st CD (111_65e_CD) and collected valuable comments from NCs. The experts discussed how to respond to those comments at 5th meeting and contributed to the compiled list of comments with observations (111/71A/CC) issued January 2007. But even after that, the experts still continued discussion to improve our draft through teleconferences and the 6th meeting based on the observations of 111/71A/CC. We also reconsidered important comments once rejected on 111/71A/CC; some of them were reflected to the new modifications. The results were compiled afterwards and US team took the lead with GB colleagues in refining English text as well as reshaping into IEC format, and finally, we can provide 2nd CD for circulation.

The important issue on "the benefit of IS for ECD with horizontal nature" was also deeply discussed among experts. We understand if various product-specific areas start compiling their own standards for ECD, they must contain common parts each other, i.e. fundamentals and procedural requirements. Clause 4 and 5 of this IEC 62430 cover these common parts and we expect them to contribute to all of the product-specific ECD standards in reducing their volume and more important, securing the consistency between the products, each one of which is a member of the entire life cycle.

FORM CD (IEC)
2002-08-08

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FOREWORD

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International Standard IEC 62430 has been prepared by WG 2 “Environmentally Conscious Design for Electrical and Electronic Products and Systems”, of IEC Technical Committee 111: Environmental standardization for electrical and electronic products and systems.

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date1) 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.

Introduction

Every product and system has an effect on the environment, which may occur at any or all stages of its life cycle - raw-material acquisition, manufacture, distribution, use, maintenance, re-use and end-of-life. These effects may range from slight to significant; they may be short-term or long-term; and they may occur at the local, national, regional or global level (or a combination thereof).

The widespread use of electrical and electronic products and systems has drawn increased awareness to their environmental impacts. As a result, legislation as well as market-driven requirements for environmentally conscious design are emerging.

The goal of environmentally conscious design is the reduction of adverse environmental impacts of a product throughout its entire life cycle while balancing the environmental aspects of the product with other factors, such as its intended use, performance, safety, health, cost, marketability, quality legal and regulatory requirements. In striving for this goal, multiple benefits can be achieved for the organization, its customers and other stakeholders. Environmentally conscious design is not a separate design activity; rather it is an integral part of the existing design process. The "design" in this context includes the activities associated with the processes of product planning, development and decision making as well as the creation of policies within the organization.

The impetus to compile an international standard is triggered by common circumstances impacting industries in the global marketplace as the product’s elements (such as materials, components, and services) are provided across national borders. In response, an international standard provides a consistent approach to life cycle management.

This International Standard is intended for use by all those involved in the design and development of electrical and electronic products and systems including the supply chain, regardless of organization type, size, location and complexity, and for all types of products, new as well as modified. Standard writers in product specific sectors are encouraged to refer to this standard when developing or revising product specific standards to ensure consistency with this international standard.

This International Standard provides a set of requirements for the process of environmentally conscious design reflecting the contents of IEC Guide 114 and ISO TR 14062.

Environmentally Conscious Design for electrical and electronic products and systems

1 Scope

This International Standard specifies general procedures to integrate environmental aspects into design and development processes of electrical and electronic products; and systems, including combination of products, the materials and components of which they are composed (hereafter referred to as products).

NOTE Sector specific requirements could be covered in other standards or guidelines which are in line with this International Standard.

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.

ISO/TR 14062, *Environmental management- Integrated environmental aspects into product design and development (November 2002)*

IEC Guide 114, *Environmentally Conscious Design – Integrating environmental aspects into design and development of electrotechnical products (May 2005)*

3 Terms and Definitions

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

3.1
design and development
set of processes that transform requirements into specified characteristics or into the specification of a product, process or system.

[ISO 9000:2005, definition 3.4.4]

NOTE 1 The terms "design" and "development" are sometimes used synonymously and sometimes used to define different stages of the overall design and development process.

NOTE 2 Product development is the process of taking a product idea from planning to market launch and reviewing the product, in which business strategies, marketing considerations, research methods and design aspects are used to take a product to a point of practical use. It includes improvements or modifications to existing products or processes.
[IEC Guide 114:2005, definition 3.2]

3.2
environment
surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation

NOTE Surroundings in this context extend from within an organization to the global system.

[ISO 14001: 2004, definition 3.5]

3.3
environmental aspect
element of an organization's activities, products or services that can interact with the environment

NOTE A significant environmental aspect has or can have a significant environmental impact.

[ISO 14001:2004, definition 3.6]

3.4
environmental impact
any change to the environment, whether adverse or beneficial, wholly or partly resulting from an organization's environmental aspects.

[ISO 14001:2004, definition 3.7]

3.5
environmental parameter
quantifiable attributes of environmental aspects.

EXAMPLE Environmental parameters include materials used, energy consumption, emissions, weight, volume, rate of recyclability, etc.

3.6
environmentally conscious design
(ECD)
Systematic approach to take into consideration environmental aspects in the design and development of products and systems with an aim to reduce adverse environmental impacts.

3.7
environmentally conscious design tool
tool developed for environmental consideration in design and development of products. The term is used in a broader context covering both quantitative and qualitative tools.

3.8
life cycle
consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to the final disposal.

[ISO 14040:2006, definition 3.1]

3.9
life cycle assessment
(LCA)
compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

[ISO 14040:2006, definition 3.2]

3.10
life cycle stage
element of a life cycle.

NOTE The phrase "life cycle phase" is sometimes used interchangeably with ‘life cycle stage’

3.11
life cycle thinking
(LCT)
consideration of all relevant environmental aspects during the entire life cycle of products and systems.

[From IEC Guide 109 and modified]

3.12
organization
group of people and facilities with an arrangement of responsibilities, authorities and relationships

[ISO 9000, definition 3.3.1]

3.13
process
set of interrelated or interacting activities which transform inputs into outputs.

NOTE 1 Inputs to a process are generally outputs of other processes.

NOTE 2 Processes in an organization are generally planned and carried out under controlled conditions to add value.

[ISO 9000:2005, definition 3.4.1]

3.14
product
any goods or service.

[ISO 14040:2006, definition 3.9]

3.15
product category
group of technologically and functionally similar products within which significant environmental aspects and life cycle stages can reasonably be expected to be similar.

3.16
stakeholder
individual, group or organization that has an interest in an organization or activity.

NOTE1 Usually a stakeholder can affect or is affected by the organization or the activity.

NOTE2 Interested party is one kind of stakeholders

[ISO 14050 and modified]

4 Fundamentals of Environmentally Conscious Design (ECD)

4.1 General

Clause 4 describes the fundamental requirements of ECD to be implemented by the organization. Clause 5 describes the ECD process to be implemented on an operational basis.

4.2 Life Cycle Thinking

Environmentally Conscious Design shall be based on the concept of Life Cycle Thinking (LCT), which requires consideration during the design and development process of the significant environmental aspects of a product in all life cycle stages.

Key elements of life cycle thinking are:

– Having an objective to minimize the overall adverse environmental impact of the product;

– Identifying and quantifying the significant environmental aspects of the product;

– Considering the trade-offs between environmental aspects and life cycle stages.

The above shall be initiated as early as possible in the design process when most opportunities exist to make changes and improvements to the product affecting its overall environmental performance throughout its life cycle.

NOTE 1 As a first step in LCT, the intended function of the product should be determined. In subsequent design stages, the influence of any applied business model should be recognized.

NOTE 2 The life cycle stages of any product under control of the organization usually include the procurement and processing of materials, manufacturing, distribution, use, maintenance, and end-of-life management (including reuse, recycling, recovery and final disposal).

NOTE 3 The environmental performance of a product during its life cycle may be determined not only by its own design and use, but may also be influenced by its operation and interaction within a network of products working together (system). This consideration may influence the decisions made to minimize the adverse environmental impact.

NOTE 4 ECD requires collaboration and contributions of all stakeholders along the supply chain.

4.3 Regulatory and stakeholders' requirements

Environmentally Conscious Design is performed within the boundaries set by regulatory and stakeholders' requirements. Such requirements shall be regularly reviewed so that relevant changes are understood by the organization performing ECD.

Environmental regulatory and stakeholders' requirements may include:

– restrictions and obligations resulting from national and international regulations;

– technical standards and voluntary agreements;

– market or customers' needs, trends and expectations, e.g. criteria from eco-labels and green procurement schemes;

– societal and investors' expectations, e.g. advances in technology.

4.4 Integration into Management System

Environmentally conscious design and its objective of minimizing the overall adverse impact of the product shall be reflected in the policies and strategies of the organization. If an organization has a management system which includes the product design function, the ECD process shall be an integral part of that system, including documentation.

Environmental considerations could be one element of the overall risk management process of the organization.

NOTE "risk management" is defined in ISO/IEC guide 73

In line with the procedures of the management system of the organization, the ECD process shall be reviewed when required and at planned intervals to ensure its continuing suitability, adequacy and effectiveness. This review shall include assessing opportunities for improvement, and the need for changes to the ECD process and the related policies and strategies of the organization.

NOTE 1 The iterative process of continual improvement in product design and development can also be described by the PDCA (Plan, Do, Check, Act) cycle. This approach also provides means for managing the changing legal, technological, organizational, economic and environmental requirements.

NOTE 2 Communication regarding the ECD process and its objectives is performed within an organization so that the affected departments understand the rationale for the initiative, leading to their cooperation and collaboration.

NOTE 3 Examples of management systems are described by standards ISO 9001 and ISO 14001.

5 Environmentally Conscious Design Process (ECD Process)

5.1 General

Organizations performing Environmentally Conscious Design (ECD) shall establish, document, implement and maintain an ECD Process as an integral part of the product design and development process. This ECD process includes the following steps and is further described in the following sections:

(a) Analysis of the regulatory & stakeholders' environmental requirements;

(b) Identification and evaluation of environmental aspects and corresponding impacts;

(c) Design and development;

(d) Review and continual improvement.

During all these steps the organization communicates with relevant stakeholder (see 5.6)

NOTE: The above process from (a) to (d) corresponds to PDCA cycle as follows

Steps (a) and (b) to Plan, step (c) to Do, and step (d) to Check and Act

5.2 Analysis of Regulatory and Stakeholders' Environmental Requirements

As an initial step of ECD, to be carried out in conjunction with the identification of environmental aspects (see 5.3), the organization shall understand the relevant regulatory and stakeholders' requirements, both at horizontal and sector specific level. These requirements set the basic framework within which a product is developed.

The organization shall ensure, as appropriate, that:

(a) all relevant environmental requirements from applicable regulatory authorities and stakeholders are identified, covering,
- the relevant product functions,
- all relevant life cycle stages,
- the significant environmental aspects of the product,
- the geographical scope of the intended market, and
- the related activities of the organization;

(b) both current and foreseeable requirements are regularly reviewed and identified;

(c) a systematic analysis of these requirements is performed and documented, identifying the affected product function(s) and life cycle stage(s), related activities of and responsibilities in the organization, and resulting action(s) to be taken;

(d) new or changed requirements, which appear during the design phase are evaluated as to their effect on the product and necessary modifications are made.

5.3 Identification and Evaluation of Environmental Aspects and Corresponding Impacts

The organization shall establish a procedure to identify environmental aspects and corresponding impacts, which is comprised of the following steps:

(a) Identification and evaluation of relevant environmental aspects and corresponding impacts,

For each relevant life cycle stage, identify inputs such as materials, energy and other resources used, as well as outputs such as the product itself, intermediates, co-products, by-products and others (examples are provided in Annex B, Figure B.3), all of which cause environmental impacts.

Evaluate environmental impacts related to the identified relevant environmental aspects.

NOTE 1 The identification of environmental aspects could be done for a product category.

NOTE 2 The environmental information associated with the identified processes, materials, parts or components can be qualitative or quantitative.

(b) Determination of significant environmental aspects

After all relevant environmental aspects have been identified, significant environmental aspects are determined by evaluation and prioritization, based on their contribution to overall environmental impact. The ECD process should then address these significant environmental aspects identified for a product or product category. An arbitrary emphasis on a single environmental aspect or a single life cycle stage should be avoided.

NOTE The evaluation and prioritisation of the environmental aspects can be both qualitative and quantitative.

5.4 Design and Development

The choice of a design solution should achieve a balance between the various environmental aspects and other relevant considerations, such as function, health and safety, technical requirements, quality, performance, business risks and economic aspects. These considerations also apply to research and development of new technologies.

The following steps shall be considered during design and development:

(a) Specify the functions of the product;

(b) Define significant environmental parameters from the analysis of regulatory and stakeholder requirements and evaluation of the environmental aspects;

(c) Identify relevant environmental improvement strategies for these parameters;

(d) Develop environmental targets based on the improvement strategies;

(e) Develop a product specification addressing the environmental targets; and

(f) Develop technical solutions to meet the environmental targets while taking into account of other design considerations.

NOTE The use of ECD tools (described in annex C) and standards may be helpful.

5.5 Review and Continual Improvement

A procedure for review and continual improvement of the significant environmental aspects of products throughout the entire life cycle shall be established, implemented and maintained.

The organization shall conduct design reviews to evaluate that the product design has met the targets defined in the environmental product specification whenever significant environmental aspects are affected or a major design phase is completed. When the product environmental targets are not met, improvement actions shall be assigned.

NOTE The organization could conduct further product reviews after market launch to consider feedback from users and other stakeholders as well as additional environment-related knowledge. The results could then be incorporated into the ECD process supporting continual product improvement and the revision of policies and procedures of the organization setting the basis for product specifications for future product development.

Records of the design reviews, including the assigned actions arising from the review, shall be maintained and serve as a reference for future product development and continual improvement activities.

5.6 Information Sharing for ECD

As part of the ECD process, organizations may exchange information along the supply chain on environmental aspects of their ECD process.

Exchanging the above information assists the organizations involved in the design process to ensure that environmental targets are achieved. Examples of information exchanged include:

- Relevant resources used in the product, used in the manufacturing of the product or used in the operation of the product;

  EXAMPLE: Resource usage includes water, energy and materials.

- Guidance to optimize environmental performance;
- End of life treatment;
- Self declaration indicating conformance with regulatory and customer requirements.

Annex A
(Informative)
Corresponding to Clause 4 - Fundamentals of Environmentally Conscious Design

A.1-Clause 4.1 General

ECD is based on Life Cycle Thinking (LCT) and should be part of the organisation's design and development processes (see 4.2). Figure A.1 illustrates how ECD could be incorporated into the (existing) management system of the organization (see 4.4).

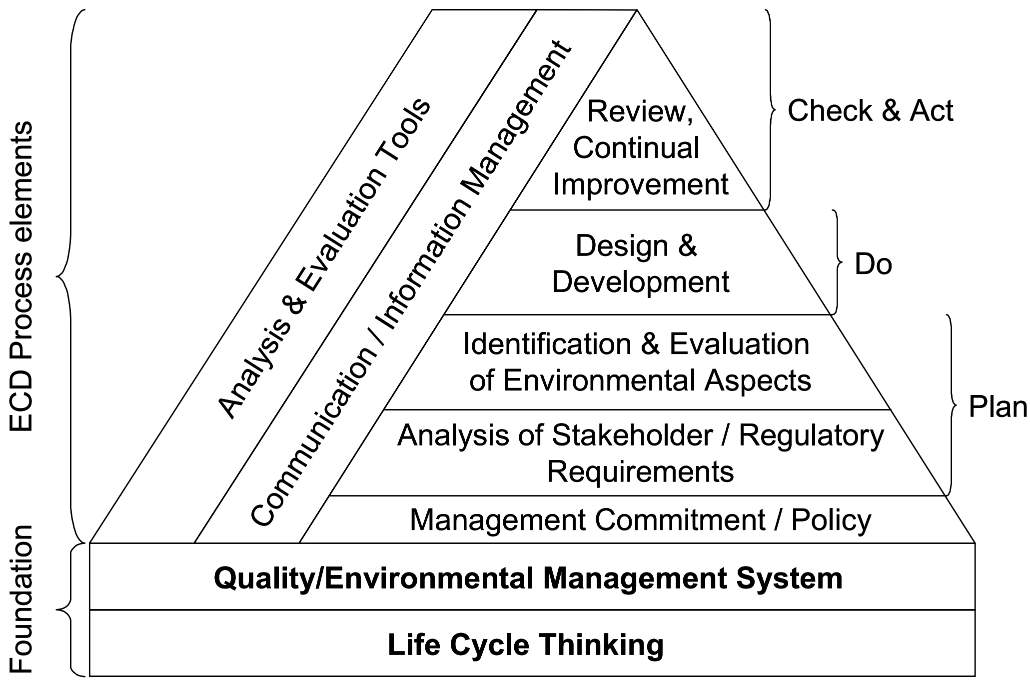

Fig A.1 Overview of ECD process

As indicated in Figure A.1 , the ECD process is composed of sequential steps in line with the Plan, Do, Check and Act principle and supporting tools/processes which can relate to the sequential steps

A.2-Clause 4.2 Life Cycle Thinking

'Life Cycle Thinking' is essential for performing ECD. Elements of life cycle thinking can include:

– Comprehensive view: Rather than arbitrarily focusing on one life cycle stage or aspect of the product, all such stages are considered during the design process from the environmental as well as from other business perspectives, maintaining the goal of overall improvement of the environmental performance;

– Business strategy: Rather than focusing on product improvement from a specific environmental aspect only, consider changes to the business model (product service systems, end of life options, etc.) that emphasize providing value, functionality, and service to the customers,;

– Understand the life cycle: When considering the life cycle you should include end-of-life aspects (e.g. lifetime, disposal reasons, collection rate, and critical components to be disposed off) and (secondary) raw materials potentially to be recovered ('cradle to cradle').

As far as is possible, take into account the effects of impending regulatory requirements, changes to related product families and advances in technology or the projected availability of devices with competing functionality (e.g. the replacement of CRTs by LCDs);

– Strategy for implementation: Balance environmentally adverse effects with other relevant factors like health, safety, function, performance, marketability and cost. Define goals to be realised by ECD at the applicable life cycle stages (including maintenance, upgrading and management options at end of life).

A.3-Clause 4.3 Regulatory and Stakeholders' Requirements

Environmentally Conscious Design is performed based on regulatory and stakeholder requirements, changes in technology, market trends as well as the policies and procedures of the organization.

These requirements may address aspects or parts of the supply chain not directly under control of the specifying organization but still affecting the product.

The organization should regularly review the relevant internal and external requirements and incorporate those that are relevant into the ECD process.

A.4-Clause 4.4 Integration into Management System

The decisions made by management determine the framework and targets of the ECD programme, the level of support the work will receive (including financial and human resources and time allocated for the tasks) and the degree of success at minimising adverse environmental aspects the programme will achieve. Top management support addressed to all involved internal and external stakeholders is needed to achieve a significant effect on an organization's product design and development activities.

For an effective and continual implementation of ECD processes and procedures, it may be best to integrate ECD in an existing management system of the organization such as a quality or environmental management system; indeed, where an organization has a management system which includes the product design function, clause 4.4 requires that the ECD process be integral to that management system. Integration of the ECD process into a management system would:

– Leverage the general elements of an existing management system (e.g. system review, communication);

– Ensure consistency with the basic framework of the organization including high level policies and targets.

The success of integrating environmental aspects into product design and development in an organization is enhanced by involvement of all relevant disciplines and competencies rather than limiting the task to design and development. The aim should be to ensure that all relevant business functions contribute and commit to environmental improvement in the earliest stages of the design and development process and remain involved throughout the process, up to and including market launch and product review.

Risk assessment may be helpful to identify stages during a product's life cycle that can result in adverse environmental effects or in a potential non-conformity with specific regulatory or stakeholder requirements – such an input can also lead to improvements of the ECD process. An example of a risk assessment activity could be Failure Modes Effects Analysis (FMEA) focusing on environmental aspects. Environmental risks that exceed a level defined by the organization would trigger action, which could typically either be a risk management assignment in the organization or a design improvement task.

Annex B
(Informative)
Elaboration of Environmentally Conscious Design Process (ECD Process) (see Part 5)

B.1 Outline of ECD Process (see 5.1)

(a) Table B.1 provides examples of general steps for integrating environmental aspects into the design and development process.

Table B.1 Examples of procedures for ECD Process

Phase	(a)-(d) in Clause 5.1	General tasks	Leading questions	Examples of tools
1. Product planning	a	Describe the product's environmental parameters	What are the elements and life cycle stages of the product?	
	a	Identify the regulatory and market requirements; the needs of customers and other stakeholders; and relate these to the environmental aspects to be achieved throughout the life cycle of the product	Who are the stakeholders and what do they expect from the environmental attributes of products?	ECD checklist
	a	Benchmark against the competitor's products	What are the competitor's product's environmental strengths and weaknesses?	ECD benchmarking
	b	Acquire information from the supply chain	What information on relevant life cycle stages and environmental aspects is needed? (e.g. materials content and energy consumption of components)?	
	b	Identify significant environmental aspects and relevant parameters; • Develop a life cycle flow for the product by selecting appropriate life cycle stages, including concepts for the end-of life treatment of the product • Analyse and evaluate the impacts on the environment, taking into account the foreseeable product life cycle • Compile the result of the environmental analysis and stakeholders' requirements	What opportunities are there to improve environmental attributes of the product? How to coordinate customer's needs, benchmarking results and environmental assessment results into common improvement tasks?	ECD benchmarking Environmental QFD LCT assessment tools

		b	Define environmental targets (performance objectives)	What are the technical, economical and business issues and feasibility associated with proposed improvements? What are the specific tasks and resources for achieving the environmental targets?	
2. Product design	Conceptual design (Identifying product's functions and the solutions)	c	Establish the environmental targets and requirements for the design in the design specification.	What should be the target specifications for fulfilling the environmental performance objectives?	
		c	Analysis of the product's intended functions so that these can be modified, if required, to achieve the environmental targets for the product	What are possible new functions of the product?	
		c	Assemble solutions (including new technologies) to achieve each required function within the designed product	How to generate product concept variants?	
		c	Evaluate variants against criteria, such as economic, technical, social, and environmental ones Select and evaluate a variant solution against the environmental performance objective	How to select the best product concept variant? Are the environmental performances objectives meet?	Environmental QFD ECD checklists LCT assessment tools
	Detail design (Identifying product structure, components and materials)	c	Detail and optimise the product design so as to satisfy environmental and performance requirements		Design supporting tools
		c	Optimise the product design in detail by taking various life cycle processes in to account (e.g., packaging and transportation)		
		c	Finalise the life cycle flow for the product		
	Evaluation (Ensuring that the product satisfies environmental and other specifications)	d	Conduct an assessment of environmental effects over the entire product life cycle.	Does the product satisfy the specified environmental performance objective?	ECD benchmarking ECD checklists, Environmental QFD LCT assessment tools
		d	Evaluate and test the prototype against criteria such as economic, technical, social, and environmental ones		
3. Release for production		d	Prepare the product information for stakeholders to cover the entire life cycle, including end-of-life treatment.	Who are involved in product use and treatment?	

(b) ECD Process Documentation - Knowledge management

Examples of technical documents can include:

- Description of products;
  - identification of products' information(brand name, model number; name and address of manufacturer),
  - a description of the intended function of products,
- Technical description of products;
  - a technical rationale behind the inclusion of design aspects in the products (relevant technical drawings, including block diagrams, circuit diagrams, assembly diagrams, parts list, installation diagrams, etc),
- Procedures used to ensure conformity of the products to specified requirements;
  - identification of standards and guidelines applied, requirements of regulations,
  - details of the significant design elements adopted to minimize environmental aspects and of the procedures used to control variations in the production process,
  - results of product assessment (assess environmental effects) over the entire product life cycle, evaluating, testing and prototyping variants against criteria such as economic, technical, social, and environmental ones.

An organization may adapt its existing management system in order to establish a knowledge management system that is consistent with the regulatory and stakeholder requirements.

B.2 Analysis of Regulatory and Stakeholder Requirements (see 5.2)

Examples of the sources of external environmental requirements influencing the planning, design and development of products are:

- national and international regulations affecting products, processes or international trade;
- national and international technical standards and voluntary agreements;
- customer specifications;
- benchmark reports of competing products;
- ecolabel and green procurement schemes;
- technical documentations of suppliers;
- market analysis and market trend reports; and
- studies on societal, investors and media expectations.

Examples of factors to be considered when establishing a procedure for the identification and analysis of environmental regulatory and stakeholders' requirements are:

- knowledge and expertise of staff;
- extent of requirements to be covered (e.g. technical and geographic scope);
- product categories in the organization's product portfolio triggering specific investigations;
- frequency of changes and the resulting monitoring task;
- manufacturing strategy and structure of the organization;
- internal and external resources, availability of suitable specialized services;
- cooperation with suppliers or within trade associations, and their capabilities; and
- financial and human resources available for the task.

The organization may determine the necessary actions to appropriately respond to the identified requirements based on available technical expertise and experience, and by risk assessment.

B.3-Clause 5.3 Identification and Evaluation of Environmental Aspects and Corresponding Impacts

(a) Inputs and outputs and examples of environmental impacts associated with a product's life cycle.

Products can have a range of environmental aspects (e.g. emissions generated, resources consumed) that result in environmental impacts (e.g. pollution of air, water, and soil; climate change).

A product's environmental impacts are largely caused by the inputs that are used and consumed, the processes employed and the outputs that are generated at all stages of the product's life cycle. If the product is a service, these impacts are generally related to the physical products used to deliver the service. Environmental impacts can be greatly influenced by the actions of organization(s) and individual(s) using the product. Figure B.3 shows some environmental impacts that can be associated with the product's life cycle.

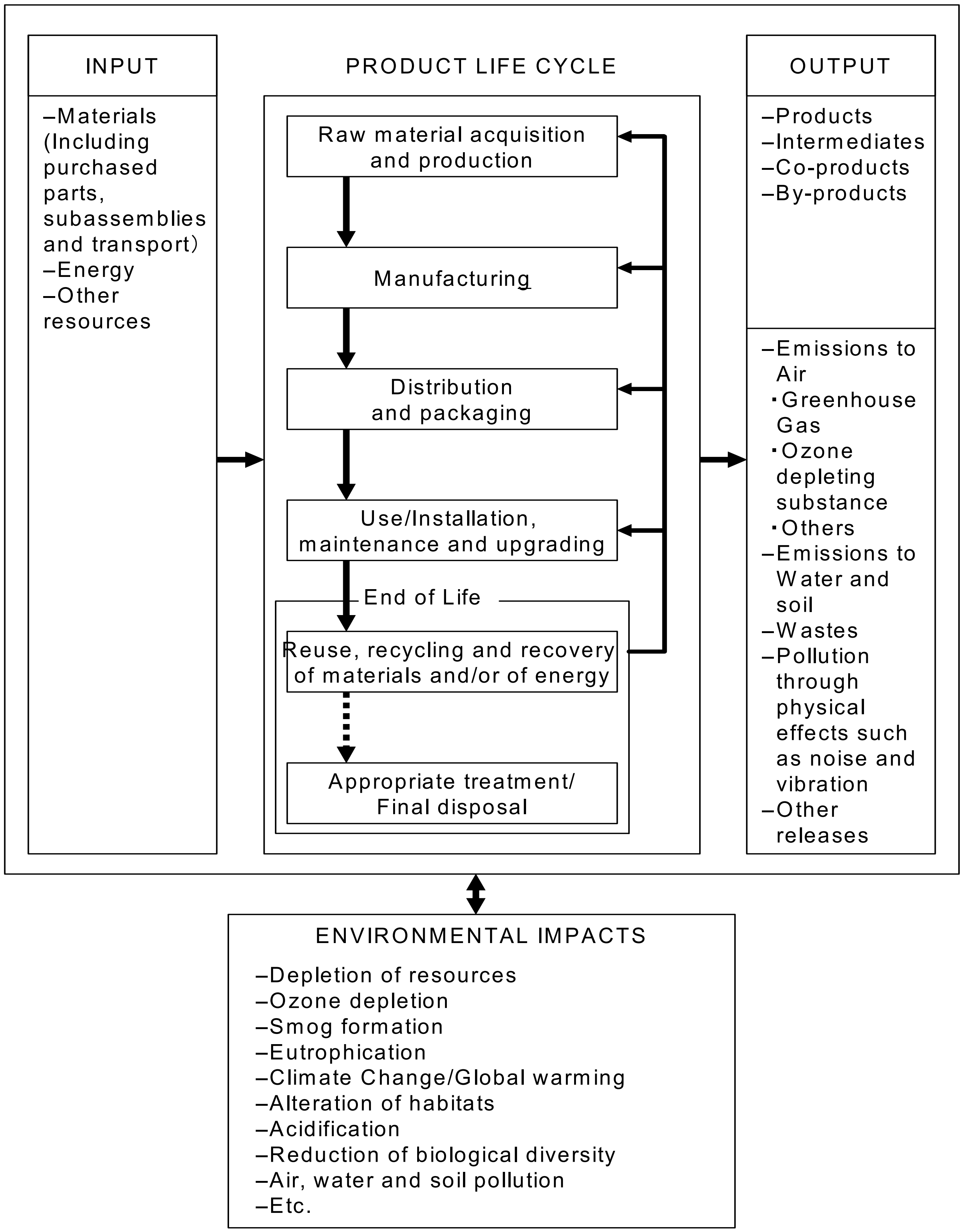
INPUT
–Materials (Including purchased parts, subassemblies and transport)
–Energy
–Other resources
PRODUCT LIFE CYCLE
Raw material acquisition and production
Manufacturing
Distribution and packaging
Use/Installation, maintenance and upgrading
End of Life
Reuse, recycling and recovery of materials and/or of energy
Appropriate treatment/ Final disposal
OUTPUT
–Products
–Intermediates
–Co-products
–By-products
–Emissions to Air
·Greenhouse Gas
·Ozone depleting substance
·Others
–Emissions to Water and soil
–Wastes
–Pollution through physical effects such as noise and vibration
–Other releases
ENVIRONMENTAL IMPACTS
–Depletion of resources
–Ozone depletion
–Smog formation
–Eutrophication
–Climate Change/Global warming
–Alteration of habitats
–Acidification
–Reduction of biological diversity
–Air, water and soil pollution
–Etc.

Figure B.3 Examples of environmental impacts associated with a product's inputs, outputs and life cycle stages

(b) Life cycle tools for identification of significant environmental aspects and impacts

Commonly used tools for the assessment of environmental aspects and impacts of a product could be based on life cycle thinking (LCT) and life cycle assessment (LCA). The former generates qualitative information and the latter quantitative information: Quantitative information yields numeric values based on reasonably objective methods; thus the information may be more reliable than that of the qualitative one. Qualitative information yields results based on pre-set parameters for the analysis, and evaluates those parameters qualitatively.

Table B.3 shows an example of the LCT approach that identifies significant life cycle stages and environmental aspects of a product.

Identification of significant environmental aspects does not necessarily need to be done by each organization itself, but could be done for a product category in a shared approach e.g. via industry organizations, research platforms or governmental bodies.

Table B.3 Life cycle stages and environmental aspects for the identification of the significant life cycle stages and environmental aspects

	Raw material Procurement	Manufacturing	Packaging Transport Distribution	Installation & Maintenance	Use	End of Life
Material / Energy Consumption	- What types of materials/energy are needed? - How much is needed?	- Does it require ancillary materials/ energy to manufacture? - If so, how much?	- Does it require packaging to transport? - Which means of transport are used? - How long is the transport distance?	- Does it require materials/ energy to unpack, set up, clean or repair the product? - If so, how much?	- Does it require materials/ energy to operate? - If so, how much?	- Does it require materials/ energy during end of life? If so, how much?
Emission	- Are there any emissions generated? -To where/How much is emitted?	- Are there any emissions generated during manufacturing? -To where/How much is emitted?	- Are there any emissions generated during transport? -To where/How much is emitted?	- Are there any emissions generated during installation and maintenance? -To where/How much is emitted?	- Are there any emissions generated during use? -To where/How much is emitted?	- Are there any emissions generated during end of life? -To where/How much is emitted?
Physical Effect (e.g. noise, electro-magnetic radiation)	- Are there any physical effects involved?	- Are there any physical effects involved during manufacturing?	- Are there any physical effects involved during transport?	- Are there any physical effects involved during installation/ maintenance?	- Are there any physical effects involved during use?	- Are there any physical effects involved during end of life?
Waste Generation	- What types of waste are generated? - How much is generated?	- What types of waste are generated to manufacture? - How much if	- What types of waste are generated during transport?	- What types of waste are generated during installation/	- What types of waste are generated during use? - How much if	- What types of waste are generated during end of life? - How much are

		any is generated? - Are there any by-products generated?	- How much if any is generated?	maintenance? - How much if any is generated?	any is generated?	they? How much if any is generated?
Possibility of Reuse, Recycling, or Recovery	- Is it possible to recover, reuse, or recycle material/ energy?	- Is it possible to recover, reuse, or recycle material/ energy during the manufacturing processes?	- Is it possible to reuse or recycle the packaging?	- Is it possible to recover, reuse, or recycle the materials/ energy which has been used to set up or maintain the product?	- Is it possible to recover, reuse, or recycle the materials/energy which has been used to operate the product?	- Is it easily disassembled? - Is it possible to reuse or recycle the materials from the waste product? - Is it possible to recover the energy from the waste product?

For each life cycle stage and environmental aspect, identify the materials and/or processes of a product system that can cause significant impact on the environment. The materials and/or processes identified as significant become significant environmental parameters. At the same time, the identification process highlights which life cycle stages are most significant.

B.4-Clause 5.4 Design and Development

The design and development process starts with the specifications of the product's functions. The environmental parameters for the product design are then defined based on the prioritized significant environmental aspects that are identified.

The organization may evaluate various design approaches with the aim of achieving a reduction in the environmental impacts of the product over its entire life cycle. The following examples of possible design considerations may be helpful in this respect:

– Functionality: considering opportunities for multiple functions, modularity, automated control and optimisation; comparing the environmental performance to that of products tailored for specific use;

– Materials efficiency: checking if environmental impact can be reduced e.g. by minimal use of materials, use of low impact material, and/or recovered materials;

– Energy efficiency: considering total energy use throughout the product's life cycle (including use phase), check if environmental impact can be reduced, e.g. reduction of energy use, use of low impact energy resources;

– Material composition: identifying substances contained in the product including purchased parts and materials, and considering the reduction or avoidance of the use of potentially hazardous substances in the product;

– Durability: considering the product's longevity, serviceability; considering environmental improvements emerging from new technologies;

– Cleaner production and use: using cleaner production techniques, avoiding use of hazardous consumables and auxiliary materials and using an overall systems perspective to avoid decisions based on a single environmental criterion;

– Packaging: material of packaging may be considered from the view point of efficient material use and information about the take-back system;

– Reuse, recovery and recycling: considering opportunities to reduce material complexity, to make resource recovery and material recycling easier and to reuse sub-assemblies and components;

– End-of-life management: considering the value of resources recoverable from products taken back, waste treatment processes and requirements, and their economic impacts on the organization.

Based upon the above described design considerations environmental strategies should be developed to improve the performance of the identified significant environmental parameters.

Environmental targets based on the environmental strategies, are then developed. Examples of these targets might include—reduce emissions by x%, improve energy efficiency by z%, reduce weight by y kg, reduce number of different materials used, etc.

The environmental targets, and other considerations such as functionality, are translated into the product specification which is the basis for the technical solutions.

Technical solutions to meet the product specification are identified in the next stage of the design and development process.

The impact of technical solutions on other product parameters, such as functionality, quality, safety, costs and marketability, are examined and decisions on trade-offs are made with the aim to find optimum solutions. This iterative procedure leads to increasingly detailed design solutions. The use of ECD tools and standards may be helpful in this stage.

An integrated perspective achieved by including environmental aspects in product design and development can help the organization in the consideration of the trade-offs which arise with most design decisions. Some trade-offs which might be encountered are:

– Between different environmental aspects; for example, optimizing a product for weight reduction might negatively affect its recyclability. The comparison of potential environmental impacts associated with each option can help decision-makers find the best solution;

– Between environmental, economic and social benefits. These can be tangible (for example, lower cost, waste reduction), intangible (for example, convenience) and emotional (for example, image). For example, making a product more robust increases the lifetime and, as a result, may benefit the environment by reducing long-term resources use and waste generated but may also increase initial costs. This may have social as well as economic effects;

– Between environmental, technical and/or quality aspects; for example, design decisions related to use of a particular material might negatively affect the reliability and durability of a product, even though this produces environmental benefits.

The product design and development process varies between products and organizations. Figure B.4 shows a model of product design and development with its typical stages and possible actions to integrate environmental aspects into the process. There are various approaches to integrate environmental aspects into the design process, and many organizations employ a combination of approaches and tools.

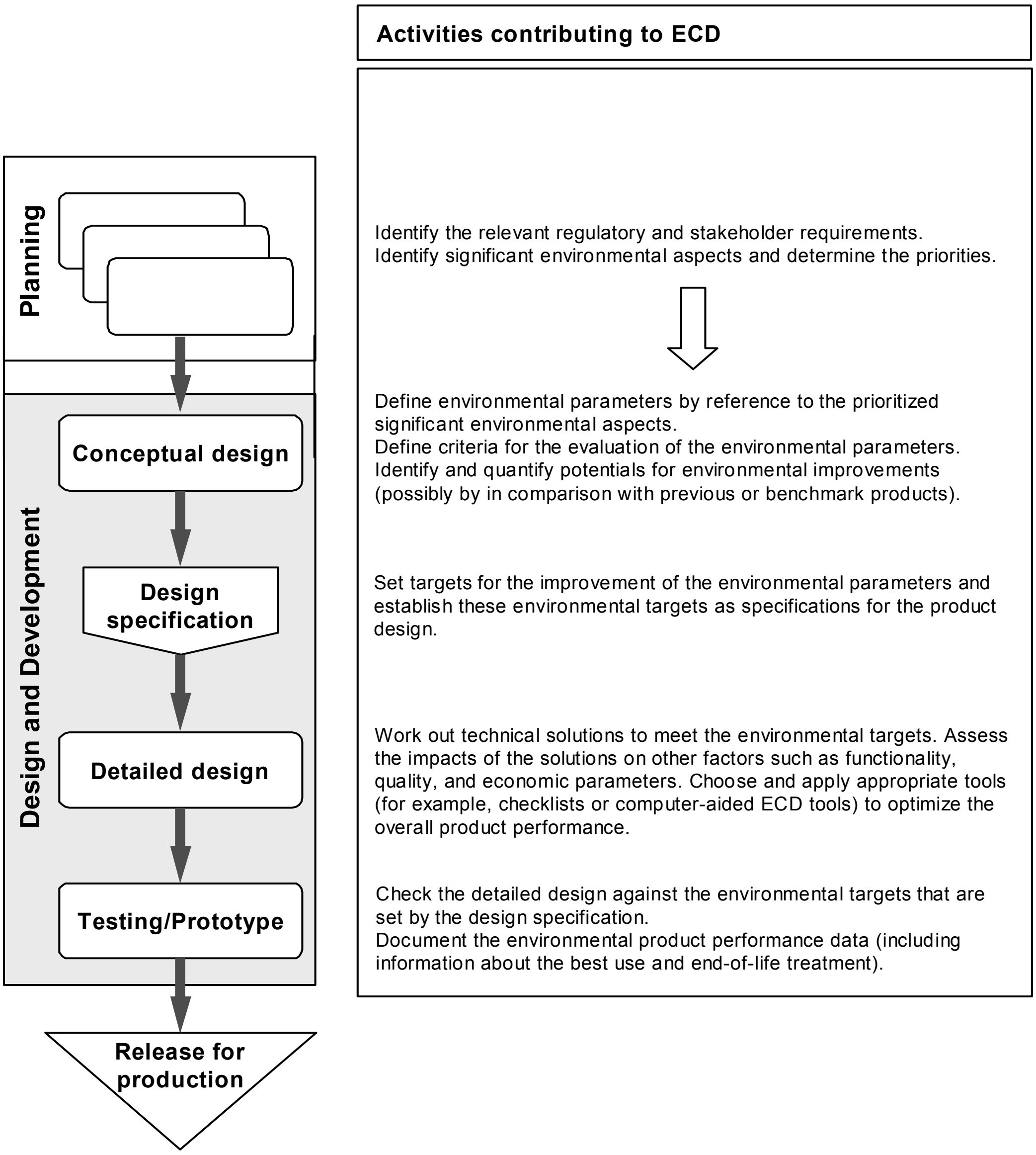

Figure B.4 Example of the integration of environmental aspects into the design and development process

B.5-Clause 5.5 Review and Continual Improvement

Product designs, at the completion of major design stages, or when a significant environmental aspect is affected, may be subject to a review to achieve continual improvement. The review may assess performance, confirm and evaluate achievement in respect to the targets and identify opportunities for improvement.

The evaluation can be either qualitative or quantitative. Examples include:

– Prevention or reduction of adverse environmental impacts;

– Eco efficiency (the ratio of functionality and environmental aspect) or ratio of improvement compared to the existing product line-up;

– Cost effectiveness and benefits.

It is recommended to record and maintain the results of the design reviews and subsequent actions with a view to continually improve the environmental performance of the products.

B.6-Clause 5.6 Information Sharing for ECD

An internationally harmonized ECD Process leads to a common understanding of ECD process information requirements. This supports collaboration among various stakeholders along the supply chain to share information for the analysis of relevant environmental aspects covering the entire life cycle. In addition, this information sharing enables effective solutions beyond the extent that a final product producer alone can contribute in terms of not only a specific product but also a global perspective (see Fig. B.6).

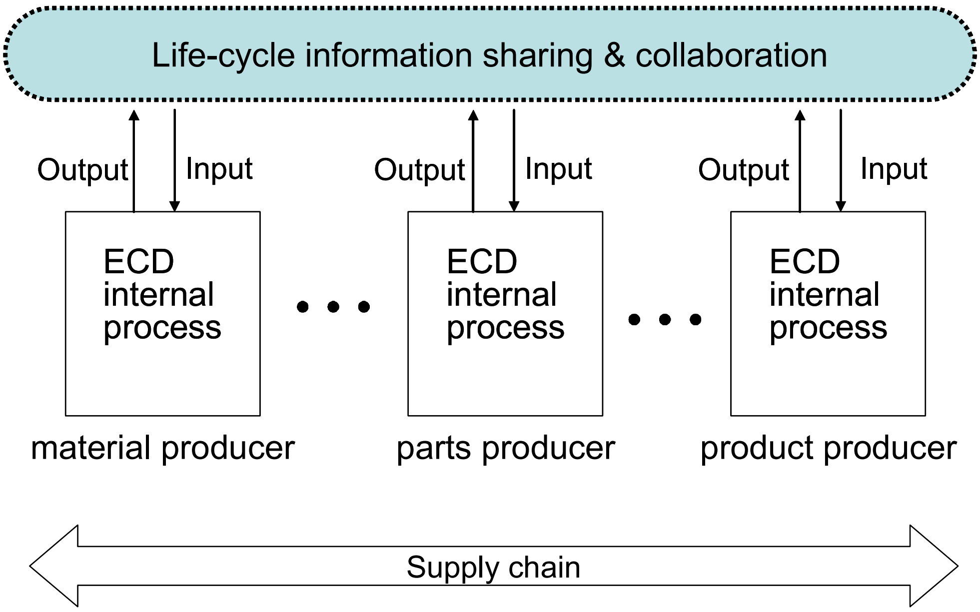

Figure B.6 Information sharing and collaboration along the supply chain for ECD Processes

Annex C
(Informative)
Examples Categories of Tools

C.1 Overview

Many of the common product design and development tools can be utilized in the ECD Process. Characteristics of tools are described below. Tools should be selected in accordance with the following criteria; they should ideally not promote only one method and be:

- Widely available and commonly recognized;
- Not too academic, but for engineering use (useful for non-experienced user);
- Globally balanced (not regional); and
- Neither too narrow nor too general in environmental scope.

Table C.1 shows the relationship between categories of tools and the general phases of the ECD process. This represents an indicative but non-exhaustive overview of useful approaches.

Table C.1 Overview of categories of tools for the ECD process

Purpose / Example of Tools	Analysis of Regulatory and Stakeholders' Requirements (5.2)	Identification and Evaluation of Environmental Aspects and corresponding impacts (5.3)	Design and Development (5.4)	Review and Continual Improvement (5.5)	Information Sharing (5.6)
1. ECD benchmarking	✓	✓		✓	✓
2. Environmental QFD	✓	✓		✓	
3. ECD checklists	✓		✓	✓	✓
4. LCT assessment tools		✓		✓	✓
5. Design supporting tools			✓	✓	

(Remark: Check mark "✓" indicated above denotes relevance of tool for a purpose)

C.2 Examples of Tools

<u>ECD benchmarking</u>

ECD benchmarking is often used to compare the environmental properties of one product against a similar product from a competitor or an industrial average. A benchmarking tool can be used in various stages in the ECD process beginning with the analysis of regulatory and stakeholders' requirements, proceeding to the identification and evaluation of the environmental aspects and corresponding impacts, review and continual improvement, and information sharing along the supply chain. Common formats for presenting ECD benchmark results are tables, graphs and spider diagrams.

<u>Environmental Quality Function Deployment</u>

Environmental Quality Function Deployment (QFD) is a method to systematically link stakeholders´ environmental requirements to environmental parameters of the product. It can be used at various stages in the ECD process. For example, it could be used to transform customer environmental requirements into design parameters, and, the setting of target values for product environmental improvement over extended periods of time, and to help in the identification and evaluation of environmental aspects and corresponding impacts throughout the product's life cycle..

ECD checklists

The ECD checklist is a simple tool to evaluate and record the environmental performance requirements or impact of a product, at each life cycle stage. Different checklists can be used to, for example, focus on minimisation of materials used; reduction of energy consumption; and greater use of recycled components or assemblies. Although checklists can be used at any stage of the ECD process, they generally have the greatest effect in the earliest stages of the ECD process since this is when the various trade-offs can most readily be accommodated.

Life Cycle Thinking assessment tools

- Simplified methods

The environmental load of products, at a preliminary level, can be estimated by using a simple Life Cycle Thinking (LCT) assessment tool. Only significant environmental aspects are used as measurement criteria in this evaluation process.

- Full method

Unlike the simplified method, a full assessment of the environmental impacts caused by products is evaluated following the principles described in the ISO 14040 series of standards.

The results of performing a LCT assessment are, in practice, likely to be very different as they vary so much on the assumptions made and method of assessment employed. Therefore, comparing the findings from one product as performed by individual A with another product analysed by individual B will not lead to a statistically significant result. At this time, the best way to ensure consistency is to ensure that one individual performs the analysis and that they identify the various simplifications made and values determined. Nevertheless, the result of LCT assessment can be used in identification and evaluation of environmental aspects and corresponding impacts, review and continual improvement, and information sharing along supply chain.

Design support tools

Design support tools include those which facilitate the optimum selection of materials and production processes, as well as those for the analysis of environmental impacts of different design options taking disassembly and end-of-life treatment into account.

- Disassembly and recyclability assessment tools

  Design of a product for ease of disassembly and recyclability could be one of the environmental targets resulting from the identification and evaluation of environmental aspects during the ECD process. In order to design the product for ease of recyclability, it is helpful to utilise the 'recyclability evaluation method'. This tool quantitatively evaluates the ease or difficulty of recycling the product by estimating the disassembly time, recycling rate, recycling costs, etc. by using the information on materials, mass, disassembly operations of the product design. Various design options such as selection of materials and surface treatment, possibility of reuse and recycling can be easily incorporated into the evaluation.

- Material selection support tools

Materials selection is a key step in determining how eco-efficient the product can be made, without either increasing its cost or degrading its functionality. The use of a tool which incorporates selection of materials and evaluation of cost, resource efficiency, functional performance and environmental impact of the materials is also helpful.

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