Environmental Effect Analysis (EEA)

– Principles and structure

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Nyckelord

Activity
EEA
FMEA
Life cycle
Life cycle phase
Environmental aspect
Environmental effect
Environmental effect analysis (EEA)
Environmental auditing
Product

Preface

This document describes the principles and structure of Environmental Effect Analysis (EEA). It has been produced jointly by HRM/Ritline, the Kalmar Institute of Technology, IVF Linköping and VI, the Association of Swedish Engineering Industries. Its purpose is to co-ordinate and facilitate application and further development of the method.

Introduction

Increasingly, present-day environmental work is concentrating on allowing for the internal and external environmental effects of a product right from the product development stage, thus minimising undesired environmental consequences in the most effective manner. **Environmental effect analysis** is a qualitative method of assessing the environmental impact of a product, and is intended to be a tool to facilitate companies' work with environmentally-considerate product development.

Contents

1. Content

This document describes the general structure, principles, application and reporting of the environmental effect analysis method. It does not describe the various methods of evaluation that are available and which, in some cases, should be customised to suit particular specific company requirements.

2. Background

Environmental effect analysis was developed in the middle of the 1990s in response to the need to find a simpler and faster method of assessing environmental impact than was provided by the available methods at the time, e.g. life cycle assessment. Important requirements that any method had to meet included a sound underlying pedagogical structure and recognition of the needs of designers, in order to facilitate implementation of the method and increase its acceptance. At the same time, it had to be suitable for use within environmental management systems such as ISO 14 001 or EMAS (ISO 14 000:1998, ISO 14 040:1998).

The FMEA methodology has achieved a strong foothold in industry, and is used by many companies applying quality management systems to their product development in order to prevent quality problems. FMEA - Failure Mode Effect Analysis - is a method of systematically identifying the possible ways in which a design or process could fail, together with their causes and resulting effects. Environmental effect analysis was developed with FMEA as a model.

One of the companies that was among those starting development of a modified FMEA with an environmental perspective at an early stage was HRM/Ritline AB. Its ideas were presented to a number of companies, including Volvo Car Corporation, which realised the potentials of using the method of working in its product development activities.

At the end of 1997, the Association of Swedish Engineering Industries (VI), working through its Recycling Committee, commissioned IVF Linköping to produce a simple aid for environmentally-considerate product development, based on traditional FMEA methodology. This work was carried out in conjunction with Volvo Wheel Loaders AB, and resulted in a method very similar to that which had previously been developed (Magnusson and Franzen: 1999).

During 1998-99, several companies showed an interest in, took up, and started to use, the method. In addition, within the framework of a project financed by NUTEK, the Kalmar Institute of Technology has continued development of the method, in conjunction with a number of commercial organisations.

The method has also been introduced internationally: the first time in conjunction with the Fifth International Seminar of Life Cycle Design at the Royal Institute of Technology in Stockholm on 19th-18th September 1998 (Nilsson, Lindahl and Jensen: 1998).

3. Purpose and objectives

The purpose of environmental effect analysis is to identify and assess significant potential environmental impact by a product during an early stage of development, in order to be able to consider the use of alternative materials, processes etc. This prevents or reduces the adverse environmental impact of a product throughout its entire life cycle in a simple and effective manner.

Environmental effect analysis uses available skills, in conjunction with earlier experience, in

order to reduce the environmental impact of products. It is important to emphasise that the main aspect of an environmental effect analysis is concentrated on analysing the performance in respect of the environmental requirements applicable to the product, and that the review work is an across-the-board operation involving several departments in a company.

An environmental effect analysis attempts to identify the factors that can be regarded as particularly important when working to reduce the environmental impact of the product.

A further objective of the method is to act as a pedagogic tool. All those involved learn to recognise the environmental impacts that can arise, thus automatically enhancing their general environmental skills.

4. Method of working

Environmental effect analysis is a systematic process that is carried out by a multi-functional group. It consists of a number of activities that should be coordinated with other elements of product development work. The various activities – preparation, environmental auditing, follow-up and reporting – are plotted in the project plan prepared before the project starts.

The preparatory work consists of collecting relevant information concerning the product, its life cycle and the environmental impact associated with it. Of particular interest are present and expected legislatory requirements, market requirements and internal requirements (management documents, internal environmental objectives), together with information on the materials used in the product, its manufacturing processes, how it is used and how it should be disposed of and/or recycled. If life cycle analyses have previously been performed, their results can provide valuable input data for environmental effect analysis. It is important to emphasise that all this data acquisition should be comprehensive, although not necessarily detailed to the extent of exact quantified information.

Environmental impact assessment involves the participants in the working party jointly filling in the environmental effect analysis form. Impact assessment is performed on the basis of the product's entire life cycle, which can be divided into various phases, such as Procurement - Manufacture - Use - Disposal. The composition of the working party may vary, although it should include representatives from design, production, marketing, purchasing and project management. Impact assessment work can be under the direction of somebody with good environmental knowledge, and who is also thoroughly familiar with the company's products and product development. The results of the assessment are in the form of identification of those environmental impacts that are the most serious, and for which appropriate countermeasures can be suggested. Examples of such measures include the use of different materials, manufacturing methods or components, specifying environmentally-related requirements that should be included in the performance specification of the product/project, seeking further information or investigating alternatives.

When the various measures have been applied, it may be appropriate to perform a further environmental impact assessment, in order to check that the measures have given the intended positive results and effected an overall reduction of environmental impact. This second assessment should be performed by the same group that performed the original assessment.

The final stage of the process is documentation. This is important in being able to communicate the results and to simplify the work of environmental effect analysis for the next product development project.

Environmental impact assessment should be carried out at an early stage of the development project in order to provide the best prospects of influencing product development. Figure 1 is a diagrammatic representation of a product development project, with the environmental impact assessment being planned to follow the initial stage of deciding on technical and environmental requirements, and thus enabling the results of the assessment to influence the detailed technical performance specification.

5. The form

A special form (Figure 3) is used when carrying out an environmental effect analysis. It is an aid to ensuring the systematic method of working that is one of the main benefits of the environmental effect analysis method.

The form is divided into four different parts: the top of the form, the inventory section, the evaluation section and the actions section (Figure 2).

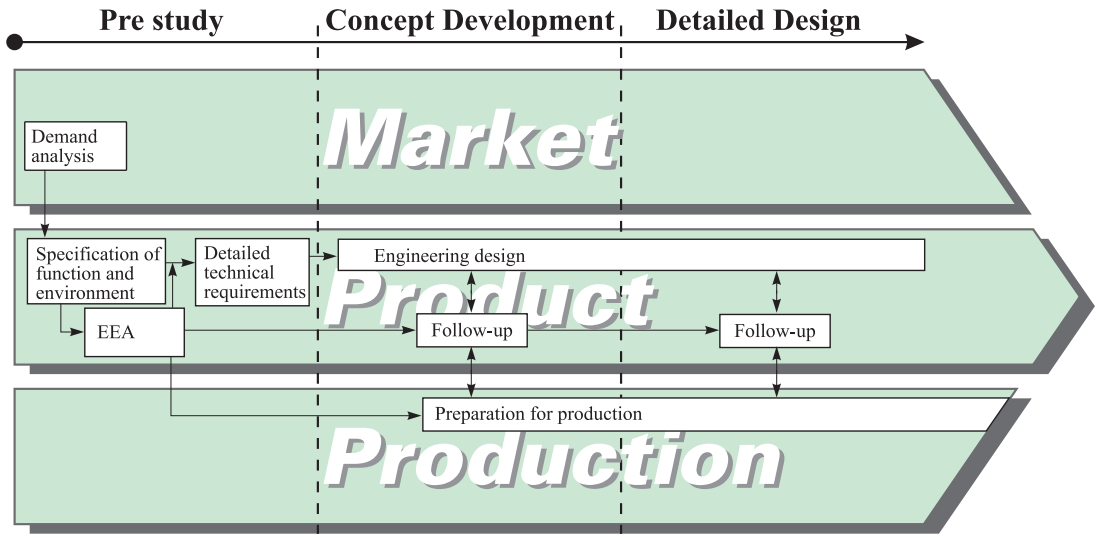

Figure 1. Diagram of a product development project, with environmental impact assessment being planned ahead of the detailed determination of technical requirements.

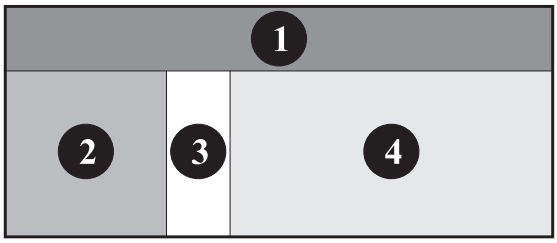

Figure 2. A form consists of four sections: the top of the form (1), the inventory section (2), the evaluation section (3) and the actions section (4).

The following is a brief description of the various parts of the form, and how they should be filled in.

5.1. The top of the form

The purpose of the top part of the form is to facilitate future identification of the environmental impact assessment performed. Figure 3 shows a typical example of the form: some companies have special requirements, and it may therefore be necessary to modify the various fields. As shown in Figure 3, the fields are as follows:

- Item name - name or identification of the product.
- Item number - of the product.
- Drawing number - on the drawing used for the environmental impact assessment.
- Function - of the product.
- Date - of the environmental impact assessment.
- Edition - sequence number of the environmental impact assessment/follow-up.
- Project - name etc. of the project.
- Supplier - of the product.
- Info - other information that may be relevant for the product.
- Follow-up date - of the environmental impact assessment and of any measures recommended and confirmed.
- Page number - as several EEA forms are often needed for an environmental impact assessment.
- Environmental effect analysis project leader - the person in charge of the environmental impact assessment work.
- Environmental effect analysis team members - others involved in the environmental impact assessment.

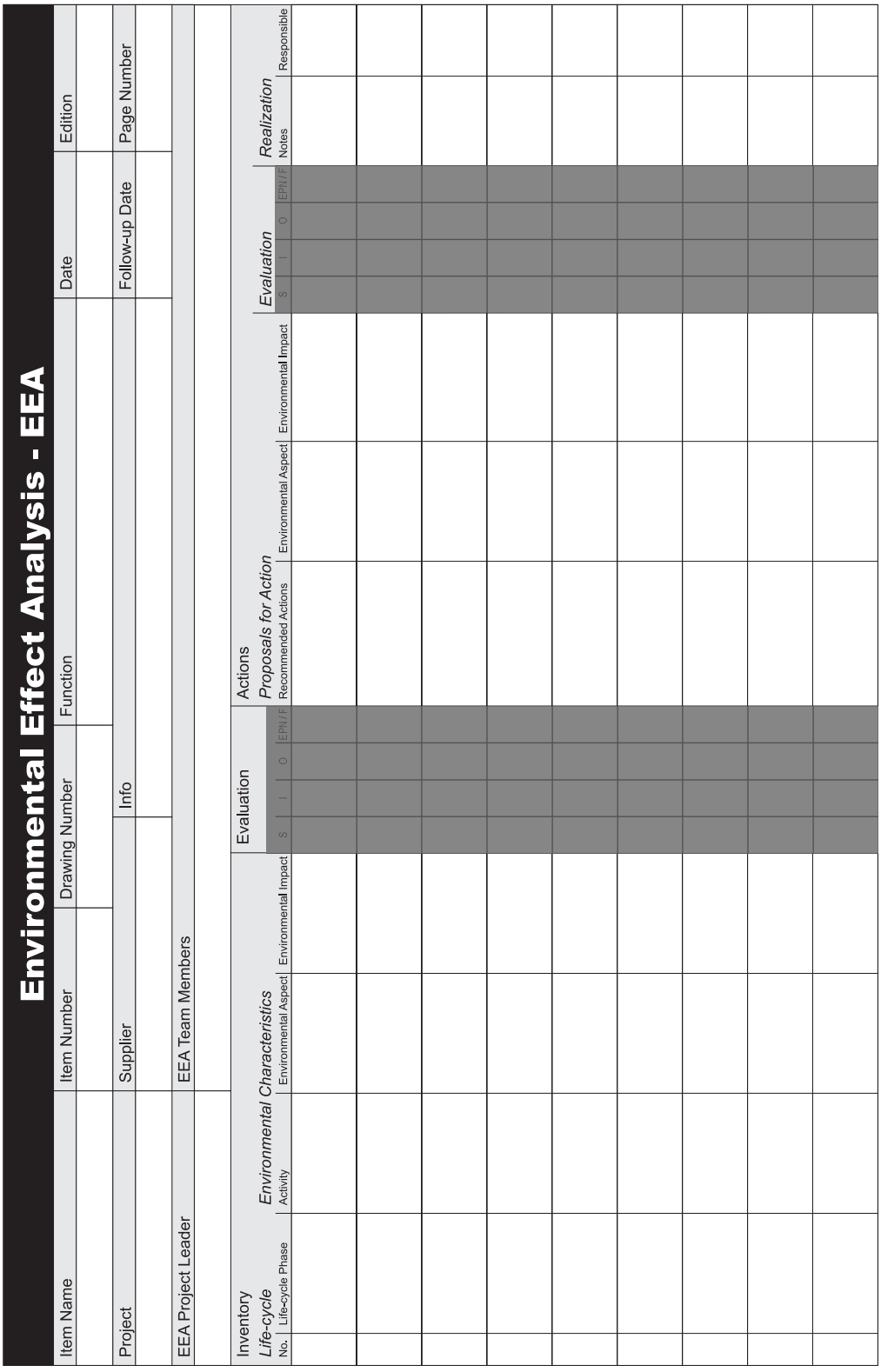

Figure 3. A typical example of a EEA form.

5.2. The inventory section

The inventory section of the form consists of two main column groups - Life Cycle and Environmental Characteristics - which are in turn divided into further columns as shown in Figure 4.

Inventory				
Life-cycle		*Environmental Characteristics*		
No.	Life-cycle Phase	Activity	Environmental Aspect	Environmental Impact

Figure 4. The inventory part of the environmental effect analysis form.

5.2.1. Life cycle

No. - A sequence number for the respective activities, in order to facilitate identification.

Life cycle phase - This column indicates during which life cycle phase the particular activity occurs. Selection of these phases depends on the extent and limitations of the environmental impact assessment. However, the commonest life cycle phases are:

- Purchasing
- Manufacture
- Use
- Disposal

5.2.2. Environmental characteristics

Activity - An event or a stage at or during which an environmental aspect arises. Examples of activities include injection moulding, dismantling, welding etc.

Environmental aspect - An environmental aspect is a result from an activity which, in turn, is related to the product. Environmental aspects are defined as follows:

- Consumption of resources, in the form of energy, materials, water or ground.
- Emissions to air, water or the ground.
- Waste and waste products (hazardous waste and other waste is defined in environmental legislation).
- Miscellaneous, e.g. noise and vibration.

Environmental impact - External and/or internal effects on the surroundings, caused by an environmental aspect. Examples of environmental impact include ozone depletion, the greenhouse effect, acidification etc.

5.3. Evaluation

Having filled the inventory part of the form, the next step is to quantify the various points, for which a number of methods are available. The main principle of most of these methods is to evaluate the environmental impact on the basis of a number of parameters. Examples of such parameters include management documents, interested parties and extent of environmental impact (see Figure 3), together with potential for improvement and potential for change. These parameters can then be graded on a scale from, for example, 1-3, where 1 = a low value and 3 = a high value. Summing the parameter rankings then produces what is known as an environmental priority number (EPN). Those environmental aspects, together with their associated environmental effects, that receive the highest EPN should be given priority for improvement measures. Three parameters are usually used.

This document does not describe any special method, as more research into evaluation aspects is required before any general recommendations can be given.

5.4. The actions section

The activities that should (and can) be improved can then be selected with the help of the parameter values. The various columns are described below.

Recommended action - Starting from the given evaluation, appropriate actions are decided upon as needed in order to eliminate or reduce the environmental impact.

Environmental effects - This column is used for noting any new environmental effects to which the recommended action might give rise.

Evaluation - A new evaluation (see Section 5.3, Evaluation) is performed if necessary, in order to ensure that the recommended action results in an improvement.

Notes - This column is for notes, references and comments, e.g. reference to when a decision on an appropriate action must be made, references to documents or current investigations etc.

Responsible - Person or department within the company responsible for ensuring that the actions are carried out.

6. Reporting

An environmental effect analysis process must be appropriately documented. One of the effects of this is to ensure transparency of the process. A report should include the following information:

- Clear identification of the product for which the environmental impact assessment was carried out.
- Assumptions and limitations relating to the product life cycle.
- Decisions on actions, names of those responsible and information on required application dates.
- Date for following up the environmental impact assessment.
- The filled-in environmental effect analysis forms.

7. Strategy for acceptance and implementation

Companies wishing to apply the environmental effect analysis method should consider how they can most effectively introduce it to their organisations.

7.1. Environmental effect analysis - part of ISO environmental work

Environmental effect analyses can benefit from being integrated in, and controlled by, ISO 14001 or similar environmental quality management systems. However, before a company decides to implement the method as a normal part of its work, it should have completed one or more simpler pilot projects in order to enable the method to be modified to suit its products and its particular requirements. These first analyses can best be applied to existing products and, if possible, in conjunction with improvement projects etc.

Environmental effect analysis work can benefit from being linked to the company's general quality work. However, companies should be aware that there can be a difference in knowledge of environmental considerations in general and application of the method in particular, when compared with similar work as part of general quality methods.

7.2. Training and networks

An important factor in achieving continuity of work with environmental effect analyses is to ensure that senior persons with more in-depth knowledge of the method and of environmental matters are appropriately trained. It is their responsibility to take charge of the analysis meetings, to fill in forms and to document the work. They can also form networks with other environmental effect analysis leaders, in order to develop the method and to bring new environmental knowledge to projects. It is also an advantage if the method is included in the basic environmental training of designers. Managers and other decision-makers, too, should be trained in the method and in its potentials, in order to ensure its acceptance.

7.3. Planning and performance of the analyses

Good planning prior to an environmental effect analysis is important for its acceptance. The analysis leader should ensure that relevant technical data is available prior to the meeting: it may be necessary, for example, to interview technical specialists unable to attend the meeting itself, and to circulate information to participants in advance.

The composition of the group to perform the analysis should be such as to ensure both specialist competence and a wide representation of various functions within the company. However, it has been found that the group should not consist of more than about 6-8 persons, as there is otherwise a risk of making the work too heavy-going and of the group becoming mired in long discussions.

8. Definitions

The following definitions, most of which are interpretations of corresponding terms in ISO 14000 documentation, apply for application of the environmental effect analysis method.

Activity - An activity is an event or a stage of the work at which an environmental aspect arises.

FMEA - Failure Mode and Effect Analysis. A method of systematically identifying possible fail-

ure modes in a design or process, together with their causes and effects.

Life cycle - All the stages of a product, from the initial obtaining of the raw materials or creation of natural resources, through manufacture and use to final disposal etc.

Life cycle phase - A stage in the life cycle of a product.

Environmental aspect (environmental impact) - An emission to air, water, ground etc., resulting from an activity.

Environmental impact assessment - Part of the environmental effect analysis process, with the group meeting in order to analyse the life cycle and associated environmental requirements of the product.

Environmental effect - A change in the environment, either positive or negative, that is partly or wholly caused by the activities and environmental aspects of a product.

Product - A physical object, a service or a combination thereof that generates one or more defined functions.

9. References

ISO 140 00 (1998) ISO 14000 - Svenska Standarder för Miljöledning [*Swedish Standards for Environmental Management*], SIS Förlag

ISO 140 40 (1998) SS-EN ISO 14040 Miljöledning - Livscykelanalys – Principer och struktur [*Environmental Management - Life Cycle Assessment - Principles and Structure*], SIS Förlag

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Nilsson J., Lindahl M. and Jensen C. (1998), The Information Flow for Efficient Design for Environment – Analysis of Preconditions and Presentation of a New Tool, Proceedings of CIRP 5th International Seminar on Life Cycle Engineering, ISSSN 1400-1179, Stockholm, Sweden, September.