

HUMAN FACTORS ENGINEERING - INVESTMENT JUSTIFICATION MODEL

DEP 30.00.60.12-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP describes a method which aims to provide clear information about the advantages of Human Factors Engineering (HFE) in the design of work systems. The method aims to provide assistance with the application of design solutions in new construction and plant change projects.

This DEP outlines the benefits of HFE and describes a method to quantify both economic and non-economic (intangible) benefits of proposed design solutions.

This DEP will demonstrate that a small initial investment, generally limited to engineering costs, can result in a major reduction in the operational life-cycle costs and improvement in the conditions at work.

A driving philosophy behind the application of HFE is that strong operational performance starts with good design and that an understanding of what constitutes good design requires a detailed knowledge of how humans interact within the work system.

Identification and analysis during the conceptual design of human-machine interfaces e.g. in operational and maintenance tasks, is a critically important element for success. The result of early task analysis is a set of "user specifications" which will lead to a better design, in balance with the technical and economic specifications.

This design approach will result in a work system in which personnel function more effectively, more safely and with improved health. The advantages are expressed in improvements in effectiveness and reliability as well as reductions in plant life-cycle costs.

Insufficient consideration of the tasks to be carried out in the plant will often lead to additional investments after start-up in order to eliminate inefficiencies. Some problems will remain unsolved throughout the life-cycle, resulting in reduced integrity and efficiency of the work system as well as the risk to the health of personnel.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI and SIEP, the distribution of this DEP is restricted to companies forming part of or managed by the Royal Dutch/Shell Group, and to Contractors nominated by them.

This DEP is intended for use in oil refineries, chemical plants, gas plants, oil and gas production facilities, and in supply/marketing installations. When DEPs are applied, a Management of Change (MOC) process should be implemented. This is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this document as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (6). Bibliographical information is listed in (7).

1.5 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards/DEP 30.00.60.12-Gen. folder. The DEP Administrator and DEP Author monitor these folders on a regular basis.

2. GENERAL

2.1 DEFINING HUMAN FACTORS ENGINEERING

Human Factors Engineering is the process of implementing human capabilities in the design of products, work places or work systems (plant/facility) resulting in the effective, efficient, safe and healthy functioning of people, thereby improving operational and maintenance tasks.

As a more formal definition, HFE is a multidisciplinary field that considers the integrated knowledge of human capabilities, limitations and needs in the interaction between humans, technology and the working environment.

HFE includes the design of user centred products, workstations and work systems. This science also addresses organisational issues and looks at how the job and tasks are structured and designed within a wider context so that human efforts are optimised and result in the greatest return for the organization.

The term 'Ergonomics Design' is used by many organisations (e.g. ISO) and can be considered synonymous with Human Factors Engineering (HFE). Shell has adopted the latter term which will be used throughout this DEP.

Synonyms of the above description include "User-centred Design" and "Usability Engineering", with the latter term being used with regard to IT projects in particular. For additional information, see (7).

HFE aims to optimise the part of the work system known as the Human-Machine Interface (HMI). It specifically focuses on optimising the cognitive and physical aspects of the interface between humans and the technical system.

HFE covers the following knowledge areas:

- task - human reliability analysis;
- anatomy, physiology;
- psychology, psycho-social factors;
- workplace and environmental factors;
- information transfer;
- business and labour management;
- design methods;
- project management.

2.2 OBJECTIVE AND TARGET GROUP

Although operating and maintenance aspects are included as integrated elements of "a good design", it is often found that the operation and maintenance of the plant, or any other work system, lead to many human efficiency problems.

Lessons learned from previous projects have proved that HFE in projects can lead to an improvement in both operating results and working conditions.

The primary objective of the model is to be used as a tool by process engineers, discipline engineers, human factors engineers, ergonomists, project management and operational/maintenance line management during decisions to be made in preparation and execution of projects.

The model also aims to highlight "a balanced design". This means that both the technical requirements and the requirements associated with the acceptable and efficient performance of personnel should be considered. Experience shows that creating balanced

designs generally does not lead to additional investment costs. However, additional investment would be required if undesirable situations had to be changed at a later date.

2.3 HUMAN FACTORS ENGINEERING AND ITS EFFECTS ON BUSINESS OPERATIONS

2.3.1 General

The early identification and analysis of critical Human-Machine Interactions in operational, maintenance and other activities, i.e., during the development stage of new construction and plant change projects, is extremely important. For example, this analysis is carried out in accordance with DEP 30.00.60.10-Gen. The analysis results in a specification with "user requirements" for the design of the human-machine interactions.

Considering the identified "user requirements" to be of equal importance to the "technical and other requirements" from the start of the design activities will result in a more effective design which will lead to improvements in operations, maintenance, reliability and HSE aspects.

2.3.2 Management structure for Human Factors Engineering in design

To implement the above improvements, design processes require the following preconditions to be realised:

- Maintenance and operations tasks are analysed in the development phase of the project, and the identified critical human-machine interactions are translated into "user requirements". These requirements are then included in the Basic Design and Engineering Package (BDEP) or Project Specification (PS) for the project;
- During the engineering phase, the "user requirements" (that were established beforehand and during the development phase of the project) should be included in the same way and with the same priority as other technical specifications;
- The relevant technical disciplines, Manufacturers and Contractors should also ensure that the HFE requirements are fulfilled;
- The experiences of the end-users should be integrated in the design;
- The HFE process should be ensured through an appropriate management structure, including the availability of competent Human Factor Engineers.

A design and project approach in which the above conditions are firmly integrated will result in a design on the basis of the identified requirements for efficient operations.

2.4 WHY HUMAN FACTORS ENGINEERING IS NOW CONSIDERED AS PART OF THE DESIGN PROCESS

Designers and vendors are faced with a wide range of requirements such as those concerning economics, technical, social, legal, political, safety, health and environmental matters. In the past, human factors engineering operational and maintenance requirements were rarely included in designs, or only on an "ad hoc" basis. This was due to:

- No clear policy towards HFE in design; experts were often involved too late in the design process, resulting in delays, additional costs and scope changes. This led to the misunderstanding that HFE only adds costs and therefore is a luxury.
- An unclear status of HFE: the scope was thought of as limited to the design of e.g. "tables and chairs", rather than production plants.
- The belief that no HFE standards are available and, if they were, that they were "not fit for purpose" for the energy industry.
- Those contributing to the design of plants were insufficiently trained in task analysis and the application of HFE principles.
- The erroneous assumption that just using common sense was sufficient to obtain an ergonomically valid design.

There are two ways to improve this situation:

1. Solving operational and maintenance human factors problems retroactively; i.e., after start-up of a new facility.
2. Ensuring operational and maintenance problems are prevented by continuous recognition of user specification during all stages of the design process.

The latter approach is preferable as corrective engineering costs significantly more than an ergonomically sound design. However, in both cases a suitable cost/benefit analysis should be undertaken to justify any additional investment.

3. JUSTIFICATION OF HFE INVESTMENTS

Once a human factors engineering problem has been identified and a solution has been designed, the investment has to be determined. Figures 1a and 1b shall be used for the evaluation and justification of HFE Investments. In order to justify a design initiative the benefits of the solution have to be identified. Appendix 1, Quick Reference Matrix – Benefits of HFE can be used to help identify potential benefits.

An economic evaluation can be undertaken quickly if the advantages are clearly demonstrable and quantifiable. Quantification of Benefits is described in (4).

However, while some of the benefits can be measured in economic terms, others cannot. The operating benefits that cannot be expressed in economic terms are ranked by a method described in (5), utilizing the "HFE Risk Reduction Matrix". The most important operating benefit that cannot be quantified economically is then used to "relax" the conventional economic decision-making criteria.

Hence, HFE investments may be justified on the basis of:

- Economic considerations, by the application of normal economic justification criteria;
- The seriousness of the potential risk based on a ranking of the operating benefits which cannot be economically quantified;
- A combination of both, in which the ranking of the non-economic benefits may lead to a relaxation of the normal economic justification criteria.

The purpose of ranking and the relaxing of the economic criteria is not to justify ergonomic investments which cannot be quantified in economic terms, but to stress the importance of the benefits of HFE design which cannot be quantified only with difficulty or not at all.

If it is found that the design (hardware/or software) solution investment cannot be justified then it should be investigated if the risks associated with the HFE problems can be controlled in other ways, for example through a procedure or work instruction.

For reference purposes various case studies can be obtained from Shell Health Services (SI-SHS).