

HUMAN FACTORS ENGINEERING - APPLICATION DURING CONSTRUCTION

DEP 30.00.60.14-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for Human Factors Engineering (HFE) activities during a project's construction phase. Its aim is to ensure that the operational and maintenance HFE criteria specified during the project engineering phases (FED/1/2/3, Implementation) are met.

In particular this DEP covers the requirements for the application of HFE to systems, installations and constructions that are engineered and installed by a Construction Contractor (CC), not to pre-engineered designs.

The purpose is to ensure that the implementation of HFE in CC engineered/fabricated installed units and/or systems results in units and/or systems that can be operated and maintained by personnel in an easy manner with minimum effort and within human capabilities and restraints.

This DEP is applicable both to projects where construction management is a responsibility of the Principal and to projects where that responsibility is delegated to a Contractor. It is relevant for the Principal's project and construction managers, construction supervisors, operations and maintenance staff, and Construction Contractors.

This DEP is one of a series of DEPs covering HFE activities and should be read in conjunction with the other DEPs in the 30.00.60.xx series, of which the following have been published at the time of publication of this DEP:

DEP 30.00.60.10-Gen.	Human Factors Engineering - Project Design Procedure
DEP 30.00.60.12-Gen.	Human Factors Engineering - Investment Justification Model
DEP 30.00.60.13-Gen.	Human Factors Engineering - Valve Analysis
DEP 30.00.60.15-Gen.	Human Factors Engineering - Human Machine Interface and Control room design

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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

This DEP is intended for use in oil refineries, chemical plants, gas plants, oil and gas production facilities and 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.

1.3.2 Specific definitions and abbreviations

AFC	Approved for Construction
CAD	Computer Aided Design
CC	Construction Contractor
CM	Construction Manager
CSU	Construction Supervisor
FED	Front-end design
FEEEM [®]	Front End Ergonomics Evaluation Matrix design analysis
FPHFEC	Focal Point HFE Construction: responsible party within Construction Contractor for coordination of HFE activities during Construction phase
FPHFED	Focal Point HFE Design: responsible party within Engineering and Procurement (FED/1/2/3, Implementation) for coordination of HFE activities during the Conceptual and Implementation Phase
HFE	Human Factors Engineer(ing)
HFE verification round	Weekly walk-through review by construction and operational staff
HSE	Health, Safety and Environment
HSE-MS	Health, Safety and Environment Management System
I(S)BL	Inside Battery Limit
JV	Joint Venture
MAC	Managing Contractor
O(S)BL	Outside Battery Limit
PEFS	Process Engineering Flow Schemes
PFS	Process Flow Schemes
PHFET	Project HFE Team
Work system	System in which one or more workers and equipment act together to perform a task that is relevant to the functioning of the system

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 (4).

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 30.00.60.14-Gen. folder. The DEP Administrator and DEP Author monitor these folders on a regular basis.

2. MANAGEMENT SUMMARY

The objective of HFE during a project's construction phase is to ensure that the operational and maintenance HFE criteria specified during the engineering phases (FED/1/2/3, Implementation) are satisfied. The result is a more efficient worksystem with fewer bottlenecks, and overall lower operating and maintenance costs.

In particular, the DEP is intended to prevent field run materials and equipment from being installed incorrectly. For example, if electrical or instrumentation items (e.g., facility lighting, power outlets, junction boxes and cable trays, etc.), small bore piping or tracing are installed in work areas, routine operation and maintenance tasks may be less efficient and HSE bottlenecks created.

Construction workers are often unaware of the adverse effects that incorrectly installed field run materials and equipment can have. Without realising the consequences, they tend to select the most convenient routing for their own purposes, often restricting operability for subsequent personnel operating at the workstation. Therefore a key objective is to ensure that Construction workers are made aware of the operational and maintenance difficulties that might surface later, and that they are given the knowledge, tools, and time to avoid them.

The optimum HFE installation is achieved by:

- Engineering the installation as far as practical to avoid field fitting, providing detailed installation drawings and notes. Where field fitting is expected, enough space should be provided so that this can be done in an operable manner.
- Including requirements in construction contracts and providing construction typicals, check lists, and objectives for each type of field fit task.
- Appointing responsible construction staff.
- Creating workers' ownership through e.g.:
 - o Providing training (complete with practice sessions and refreshers) for building awareness of operation/maintenance objectives and means for achieving them. Training should include foremen, workers, and inspectors. As the workforce often expands and contracts throughout a project, the training program shall be continuous to ensure all workers are included.
 - o Providing time in the work plan to address operability.
 - o Creating a culture of operability awareness in construction e.g. a reward system that encourages construction workers to excel in this area of craftsmanship.
 - o Including operability discussions in tool box / tailgate safety meetings.
- Conducting weekly/fortnightly HFE verification rounds;
- Conducting audits.

The benefits identified are:

- Better Facility lay out,
- Reduction of re-work,
- Schedule advantage,
- Reduction of operations and maintenance life-cycle costs,
- Improvement of 'Client commitment level'.

3. HFE ACTIVITIES

3.1 GENERAL

The Principal should designate a Focal Point for HFE during Construction (FPHFEC). This person will coordinate all HFE-related activities for all project phases of the project. A brief description of each HFE activity during the construction phase is given below.

In addition, a work flowchart is illustrated in Figure 1 and a procedural scheme in Table 1, and tasks, authorities, and responsibilities are outlined in section 3.3.

An example of the HFE requirements to be integrated in the construction contractors' contracts, aiming at a proper management of 'field run' installed material and/or equipment, is given in Appendix 1.

An example of an HFE Action Plan - Construction Phase is given in Appendix 2.

3.2 ACTIVITY DESCRIPTIONS

1. Requirements for the construction contractor contracts

Towards the end of the Detailed Engineering phase the FPHFED shall make available an inventory or list of field run materials and/or equipment in the project and associated installation standards, if available. Based on this input the FPHFEC formulates requirements for the construction contracts. For this purpose, a generic document is available which is then tailored for each project: see Appendix 1 and Appendix 2, sections 4.1 and 4.2. Further inputs might be available, such as HFE analysis reports (e.g. FEEEM[®] reports), 3 D CAD model review results and/or other design review results.

2. Construction HFE kick-off

Early in the Construction phase, Construction management appoints the PHFET members. The prime tasks of the PHFET is to develop the HFE for construction plan, assure HFE competence for team members and conduct HFE verification rounds, including reporting on the findings at regular intervals.

Minimum composition of PHFET: Operations and/or Maintenance personnel of operator/owner; FPHFEC; HFE Focal Point for Construction of MAC, backed up by Human Factors Engineer; and depending on scope a selection of engineering representatives (Mechanical, Electrical and Instrumentation, Rotating and Static equipment, etc.) and / or HSE co-ordinator.

Some EP businesses arrange a so-called IPOP (Implementing Project On Paper) meeting, between contractor, subcontractors, Operations crew and Project Team to ensure all technical and safety issues are covered. It may be advisable to combine the HFE construction kick off and the IPOP meeting.

Additional items on a kick-off meeting agenda may be (see Appendix 2, section 4.3):

- Use of 3D CAD models on site;
- Use of standardised 3D CAD equipment displays showing small-bore piping, etc.;
- Arrangements concerning audits.

3. Determine training requirement

Training requirement shall be defined for two categories of personnel (see Appendix 2, section 4.4):

- Training for PHFET members: a 1-day workshop.
- Briefing session for Construction Contractors; an approx. 30 min. meeting attended by foremen and direct labour of Construction Contractors.

4. Conduct training

For the PHFET members, a 1 day workshop on 'HFE in the petrochemical industry' is generally sufficient. The briefing sessions for installation personnel last approx. 30 min.; maximum number of participants per briefing session is approx. 20, depending on presentation medium employed. See Appendix 2, section 4.4.

5. Schedule for HFE verification rounds; develop project specific checklist

A planning schedule shall be drawn up after Installation contractors are selected and before field run installation activities begin (in general during 20 % construction phase), including list of participants. A project-specific checklist shall be drawn up based on, for example, an HFE analysis report, e.g. FEEEM[®] report, and other relevant documentation. Results of model reviews can also be used as input for this checklist. See Appendix 2, section 9.

6. Conduct HFE verification rounds

During a walk-through the layout of the facility is checked against the project-specific checklist. This may include specific items such as checking operator's round, checking logistic routes, accessibility of pumps, free hoisting space, checks on sources of noise emissions, etc.

7. Implement corrections

If (potential) misfits are identified, these shall be dealt with immediately and on the spot in consultation with the Construction Contractor, in order to stress the pro-active nature of this activity. A (digital) photograph is taken of the situation concerned for reporting back to and informing the project team. Deviations from the standard are dealt with under the relevant procedure; e.g. through a "Field Change Request" or similar change management procedure of the Contractor.

8. Write HFE verification round report

A report shall be drawn up according to standard format, including (digital) photographs in order to facilitate communication and distribute to parties concerned. See Appendix 2, section 12.

9. Approval of Construction HFE report

Construction Management signs off the completed Construction HFE report.