DEP INFORMATIVE

HUMAN FACTORS ENGINEERING IN PROJECTS

DEP 30.00.60.10-Gen.

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DESIGN AND ENGINEERING PRACTICE
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INTRODUCTION TO INFORMATIVE

This DEP Informative is the companion to DEP 30.00.60.10-Gen., and provides the rationale for certain requirements and recommendations in that document.

For clarity, the section and paragraph numbering of DEP 30.00.60.10-Gen. is used in this document. Where there are no comments regarding a particular paragraph or section, these have been omitted.

The information in this document is maintained by the custodian responsible for the DEP, primarily for the following purposes:

- Documentation of the reason or background for certain requirements, particularly where those requirements have raised questions in the past;
- Inclusion of a PS Table, if applicable, to explain the reasons and give the risk ratings for requirements if they have been designated as process safety related.

This information can be used as guidance when considering deviation requests.

This is a revision of the DEP Informative of the same number dated February 2011.

EXTERNAL STANDARDS ALIGNMENT STRATEGY

At the time of issue of Version 39, there is no external standard available that can meaningfully serve as basis for this DEP. We have recognised the merits of trying to create suitable HFE/Ergonomic industry standards, but efforts to achieve this have been unsuccessful so far. We remain interested in this and continue to monitor developments.
INFORMATION PERTAINING TO COMPANION DEP 30.00.60.10-Gen.

1. INTRODUCTION

1.7 DUAL UNITS

The conversion of values from the SI system to the corresponding USC values has been made using an adaptive process (i.e., not an exact mathematical conversion). In some cases, size substitutions have been made in order to align with available products or methods customarily used in the US.

2 HFE PROCESS

Figure 1 and the flowchart in (Appendix 1) summarise all the main HFE activities (as well as role that will be primarily responsible for executing) typically conducted during the ASSESS, SELECT, DEFINE and EXECUTE phases for ORS projects, and as outlined in the Specification to this DEP: the numbers in the figure refer to the relevant sections.

![Figure 1 Summary of all HFE activities in ORS projects](image)

2.1 ASSESS PHASE

2.1.1 Initial HFE engagement

The Health Project Owner (HPO), as the Health focal point on the project, is responsible to ensure that HFE is consulted during ASSESS phase engagement with the project management. This is to ensure that HFE Screening as an activity is included in the appropriate plans and budget is set aside for resourcing of the HFE Authorised Person as well as other potential HFE resources (e.g., Engineering Contractor support).

HFE has overlaps and relationships with a number of other Shell project engineering groups and processes, which should also provide further opportunities for initial project engagement. Four of the most important are:

- **HSSE&SP Authorised Person**

A key contact is the HSSE&SP Authorised Person, who oversees the integration of HSSE&SP activities and so their Activity Plan needs to be aligned with the Health Plan and in turn the HFE Strategy. Similarly, risks from the overall project Hazards and Effects Register (gathered from the HAZID) should be aligned with any general HFE risks arising from the HFE studies that have significant impact on project HSE risk exposure or that are
recognised in the HAZID and may need to be specifically addressed in the HFE studies. This integration helps bring HFE considerations into higher level decision-making.

- **Process Automation, Control, and Optimization (PACO)**

  HFE activities supporting the development of the HMI and alarm management should be fully integrated with PACO work processes.

  The ability of humans to effectively monitor the Basic Process Control System (BPCS), and detect, diagnose and respond to alarms is widely recognised as a critical element in the safe and efficient operation of safety, environmental or production critical operations.

  Within Shell, responsibility for Alarm Management and the engineering of the Human Machine Interface (HMI) lies with PACO. Standards for alarm management and HMI design for situation awareness include DEP 32.80.10.14-Gen. and DEP 30.00.60.16-Gen. Initiatives such as Ensure Safe Production (ESP) have implemented guidance and processes for optimising human reliability in managing and responding to alarms.

- **Operations Readiness (OR)**

  There is a great deal of synergy between the objectives of HFE and those of Operations Readiness. HFE has three primary, potential interfaces with activities conducted within the OR process:

  1. Input to development and validation of the Operations Philosophy and ensuring the HFE implications of the Operating Philosophy are understood by engineering disciplines and reflected in technical thinking.
  2. Input of HFE task requirements to definition of Operations Requirements.
  3. Support to Novelty/Complexity and Operability/Maintainability reviews.

- **Flawless Project Delivery (FPD)**

  HFE has an important contribution in supporting the Flawless Project Delivery. Through its focus on identifying and removing potential design bottlenecks to human activity, ensuring the design of facilities does not encourage unsafe behaviour or procedure violations, and minimising the potential for human error, HFE directly addresses key FPD Performance Areas of ‘Operability/Maintainability’ and ‘Health, Safety and Environment’. HFE also has significant contributions to make to ‘Tightness’, ‘Prototypes’, ‘Complexity’ and ‘Testing’.

  Project Flaw Lists for FPD often include many flaws and root causes associated with human error, lack of understanding of operator/maintainer tasks, or lack of consideration of human factors during design, procurement and construction.

2.2 SELECT PHASE

2.2.1 HFE Screening and HFE Strategy

The HSSE & SP Control Framework requires projects covered by the Opportunity Realisation Standard (ORS) to conduct an HFE Screening, and if the Screening results indicate that a HFE Strategy is necessary for the project, to have that Strategy approved by the HFE technical authority (or delegate, i.e. an authorised SME). The HFE Strategy is required for managing identified project HFE issues or risks.

The Screening should be conducted in the SELECT phase. This is to ensure that HFE design standards adopted for the project during the Screening discussions can be included in the Technical Standards Selection Report, a DCAF control for the SELECT phase of the project (DCAF ID 236).

The HFE Screening is largely an engagement session with the appropriate project team members to determine the scope and complexity of the project and as a result determine the appropriate HFE Strategy for the project. It may be combined with other HSSE or OR activities/workshops (e.g., Health Risk Assessment, HAZID, Novelty and Complexity, etc.) in the interest of the effective use of project human resources.

An example Terms of Reference (ToR) for a HFE Screening is included in (Appendix 2).
2.2.2 Technical standards selection

The selection of technical standards for a project is typically conducted during the SELECT phase resulting in a Technical Standards Selection Report (DCAF ID 236). Since the HFE DEPs in the 30.00.60.XX-Gen. series, are not DEM 1 or DEM 2, it is important that those adopted by the project as referenced in the HFE Strategy are included in the Technical Standards Selection Report, which form the project’s standards baseline. Where the Project decides to adopt only DEM 1/DEM 2 requirements, the inclusion of HFE DEP’s or appropriate industry standards SHALL be done in consultation with the HFE TA.

2.3 DEFINE PHASE

2.3.1 Revise HFE sections of project HSSE & SP and other documentation

When revising the SELECT phase HSSE Activity Plan, Health Plan, and Quality Plan for the DEFINE phase of the project, the HFE work scope and activities as reflected in the HFE Strategy must be updated to replace placeholders from Project Guide 01.

2.3.2 HFE design studies

Typical HFE design studies during DEFINE phase include:

- Valve Criticality Analysis; (see DEP 30.00.60.13-Gen.)
- Task Requirements Analysis (for critical or complex tasks, or where operations or maintenance tasks are not clear); (see Appendix 3)
- Safety Critical Task Analysis or supporting ALARP demonstrations; (see DEP 30.00.60.19-Gen.)
- Materials Handling Study. This is not a study executed by HFE but the discipline has a vested interest in the outcome. This is to ensure that the design appropriately considers mechanical handling of equipment and materials during operations and maintenance activities and not overly rely on manual handling, which creates health and safety risks. (See Appendix 4).

For projects involving significant change or new design of control room and/or Human Machine Interfaces to IT systems, HFE analysis during DEFINE phase is also likely to include:

- Human Machine Interface requirements analysis (see DEP 30.00.60.16-Gen.)
- Control Room requirements analysis (see DEP 30.00.60.15-Gen.)

2.3.3 HFE design verification

HFE design verification is essential for both technical and quality assurance. It should start early to avoid costly modifications at a later stage. It is important to liaise with OR during these reviews. HFE design verification by the HFE Authorised Person has to be done against the project HFE standards and any HFE design requirements identified through the HFE design studies.

HFE verification activities during DEFINE phase will often include:

- Participating in or if necessary organising and facilitating formal and informal design reviews focusing on specific HFE requirements and issues arising from the HFE design studies. This includes checking for compliance with specified standards.
- Ensuring HFE requirements are included in relevant specifications, including invitation to tender (ITT) and bid packages.
- Supporting the reviews of equipment and packages to be procured from Suppliers.
- Supporting reviews of conceptual building layouts, including control rooms and operator consoles.
- Providing HFE support to drawing and 3D CAD model reviews (DEP 30.10.05.11-Gen.)
2.3.4 Human reliability ALARP review

This activity includes a review of the project HEMP process and the Design ALARP demonstration report conducted during the DEFINE phase, to ensure that all reasonably practical engineering and design measures to ensure human reliability in HSSE critical activities have been considered, and where practical, applied; (see DEP 30.00.60.19-Gen.)

2.4 EXECUTE PHASE

2.4.2 HFE design verification

Continued from DEFINE, verification activities during EXECUTE phase can take many forms, for example

- Review of plot plan or general arrangement drawings
- Review of equipment specifications and other design documentation
- Review of detail layout drawings, in particular vendor supplied packages and control panels/cabinets
- Participation in 3D model reviews (30%/60%/90%)
- Validation during construction inspections and walk-throughs

2.4.6 Project HFE close-out report

The Project HFE close-out report can form part of the Project close-out report (see Project Guide 12b). It should include the following as a minimum:

- Initiation: Was an HFE Strategy developed at an appropriate time to have effective input to defining the project standards, technical baseline, and organisational requirements?
- Competence: Did the project have access to adequate resource in terms of HFE competent people, and were steps taken to ensure appropriate awareness among discipline engineers and Contractors, including construction Contractors.
- Implementation: Did the project effectively implement the agreed HFE Strategy for the project and the Engineering Contractor HFE Plan (if applicable) for EXECUTE phase? Were technical HFE deviations/variances approved by the appropriate HFE TA?
- Results: Did the results of the pre start-up audit, or any other pre-commissioning inspections, indicate that HFE standards and requirements had been complied within the design and construction?
- Actions: Have all actions raised, in the HFE programme been completed or closed?
- ALARP Demonstration: Does the ALARP Demonstration include demonstration of the efforts taken to reduce risk of human error to ALARP through engineering and design?
- Remaining Risks: Are there significant HFE risks that have not been reduced to an acceptable level and that may require additional organisational controls?
- Lessons Learned: Are there any issues or learnings arising from the project experience that should be fed back to improve the HFE Process or Standards? This information should also be captured in the Project Lessons Learned Report (DCAF ID 439).
3 RESPONSIBILITIES

3.2 HFE AUTHORIZED PERSON

The selection and assignment of the HFE Authorised Person of the project, together with the relevant HFE design requirements, are crucial to the success of the project’s HFE implementation. The HFE Authorised Person must have the necessary academic credentials and relevant experience in HFE to support the HFE implementation process.

Typical examples of scope of work to be performed by an HFE Authorised Person include the following:

- Develop and provide a HFE awareness training seminar for the project engineering/design and construction personnel.

- Support the completion of the actions and HFE design studies as identified in the HFE Strategy.

- Ensure that the HFE design specifications adopted by the project are available to Engineering Contractor engineers and designers and for inclusion in Request for Quotes (RFQs) to Suppliers. HFE specifications may need to be tailored for specific Supplier packages. It is the responsibility of the Engineering Contractor to ensure HFE requirements are met for all facilities, including vendor supplied packages.

- Provide HFE specialist support to the Material Handling Study as appropriate.

- Represent HFE at relevant design and 3D model reviews during DEFINE and EXECUTE phase involving the HFE TA as needed.

- Document for follow up and closure in a tracking register all HFE design inputs resulting from formal reviews including, but not limited to: 3D model reviews, vendor packages design reviews, and layout reviews. Additionally, other HFE concerns raised are to be documented and tracked for inclusion in ALARP demonstrations.

- The HFE Authorised Person, package engineers, and Operations representatives will jointly identify specific vendor packages requiring HFE specifications and detailed HFE review. The HFE Authorised Person is responsible for ensuring the inclusion of HFE requirements, specifications, and standards as outlined in Project's Standards Baseline in the development of vendor bid packages. The HFE Authorised Person, with the Engineering Contractor HFE support (i.e. a designated focal point, when applicable), shall work with vendors to improve their designs with regard to human factors engineering where required.

- Provide the HFE Input to Design ALARP demonstration report as appropriate.

- Develop HFE/Operations and Maintenance surveillance or checklist items for inclusion in any flawless project delivery O&M checklists and validated during Construction walkthroughs prior to system completion and turnover.

- Support the drafting and delivery of a HFE close-out report by the HFE TA to project management.

3.4 PRINCIPAL HFE RESPONSIBILITIES

Figure 2 below summarizes the relationships between the Principal, Contractor, HFE Strategy, HFE Plan, and HFE Authorised Person.

- The Principal (Company) shall provide HFE Technical Authority to the Project for its duration.

- The Principal shall provide a HFE Strategy for the project (if the Screening in SELECT indicates it is required) through the HFE Technical Authority, or delegate.

- The Principal shall appoint a HFE Authorised Person for the project, to oversee the implementation of the Strategy during the DEFINE and EXECUTE phases (see above), as a minimum to provide assurance of the Contractor’s HFE scope and
design verification, and depending on the project’s contracting strategy, they may be required to conduct the HFE design studies.

- Where the project’s contracting approach is that the Contractor will implement the bulk of the HFE Strategy, the Contractor will derive and implement an HFE plan for both DEFINE and EXECUTE phases from the Strategy; i.e., conducting the design studies and providing design verification.

Figure 2 Summary of key relationships between elements of the HFE process
REFERENCES

In this DEP Informative, reference is made to the following publications:

NOTES: 1. Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

2. The DEPs and most referenced external standards are available to Shell staff on the SWW (Shell Wide Web) at http://sww.shell.com/standards/.

SHELL STANDARDS

- Human Factors Engineering - Valves DEP 30.00.60.13-Gen.
- Human Factors Engineering - Control room design DEP 30.00.60.15-Gen.
- Human Factors Engineering - Human Machine Interface design for Situation Awareness DEP 30.00.60.16-Gen.
- Plant Model Construction and Review DEP 30.10.05.11-Gen.
- Alarm Management DEP 32.80.10.14-Gen.
- Shell HSSE & SP Control Framework, HSSE Commitment and Policy DEP 30.60.10.14-Gen.

http://sww.manuels.shell.com/HSSE/

- Discipline Controls and Assurance Framework (DCAF) DCAF ID 236
- Technical Standards Selection Report
- Discipline Controls and Assurance Framework (DCAF) DCAF ID 439
- Project Lessons Learned Report


- Royal Dutch Shell OPPORTUNITY REALISATION STANDARDS ORS
- Project Guide 01: Capital Projects HSSE&SP Mgmt PG 01
- Project Guide 12b – Capital Project Close-out Report PG 12b
- Project Guide 14a - Capital Project Operations Readiness PG14a


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APPENDIX 1  HFE PROCESS

ASSESS

Is the Project in scope for ORSF (see ORS guide or speak to the Business Opportunity Manager).

YES

Project Manager shall contact the HFE TA to discuss HFE input to the project (e.g. scope of work, standards selection, HFE resources and budget, HFE awareness training, etc.). See Section 2.1.1 for more information.

NO

See the online Projects HFE Screening Tool (Contact Health for guidance).

HSSE Advisor shall include HFE sections in project HSSE & SP and other documentation (e.g. Activity Plan, Health Plan, etc.). See Section 2.1.2 for more information.

HFE TA shall conduct a HFE screening (i.e. a facilitated workshop to identify issues and further HFE studies). See Section 2.2.1 for more information.

SELECT

HSSE Advisor shall identify the relevant HFE design standards. See Section 2.2.2 for more information.

HFE TA shall prepare a HFE Strategy (i.e. the output of the HFE screening: issues, actions, further studies, DEPs, risk prioritisation, etc.). See Section 2.2.3 for more information.

CONTRACTORS ONLY

Contractor shall prepare a HFE Plan (i.e. how the contractor intends to implement the HFE strategy during DEFINE). See Section 2.2.4 for more information.

DEFINE

HSSE Advisor shall revise the HFE sections in the project HSSE & SP documentation (e.g. Activity Plan, Health Plan, etc.). See Section 2.3.1 for more information.

HFE Authorised Person shall apply the HFE Strategy (e.g. HFE design studies, which could include Valve Criticality Analysis, Human Reliability Review, etc.). See Section 2.3.2 for more information.

HFE Authorised Person shall apply the DEFINE phase activities outlined in DEP 30.00.60.19. See Section 2.3.3 for more information.

CONTRACTORS ONLY

HFE Authorised Person shall prepare a DEFINE HFE Close-Out Report (i.e. record the status of the HFE actions). See Section 2.3.5 for more information.

See Section 2.3.6 for more information.

EXECUTE

HFE Authorised Person shall apply the HFE Strategy (e.g. HFE design studies, which could include Valve Criticality Analysis, Human Reliability Review, etc.). See Section 2.4.1 for more information.

The HFE Authorised Person shall produce a plan for verifying HFE compliance during construction. See Section 2.4.3 for more information.

HFE Authorised Person shall apply the EXECUTE phase activities outlined in DEP 30.00.60.19. See Section 2.4.4 for more information.

HFE Authorised Person shall verify that HFE design requirements are applied to the Project (e.g. review drawings, layouts, 3D models, etc.). See Section 2.4.2 for more information.

HFE TA shall ensure HFE is included as a subject in the pre-start-up safety review or the pre-start-up audits. See Section 2.4.5 for more information.

HFE TA shall demonstrate implementation of the HFE Strategy in the Project Close-Out Report. See Section 2.4.6 for more information.
APPENDIX 2

EXAMPLE HFE PROJECT SCREENING TERMS OF REFERENCE

1. Introduction
The HSSE & SP Control Framework requires projects covered by the Opportunity Realization Standard (ORS) to conduct an HFE Screening. The HFE Screening is largely an engagement session with the appropriate project team members to determine the scope and complexity of a project and to identify issues of potential HFE concern, or where value may be added to the design process. The HFE Screening shall be conducted in the SELECT phase and will be used to gather information required for preparing a HFE Strategy. It is not a risk assessment.

After the Screening, projects are required to prepare this HFE Strategy for managing HFE implementation. The HFE Strategy will be issued within four weeks of the HFE Screening workshop and the final version is subject to the approval of the HFE Technical Authority or delegate (i.e., an authorised SME, as per the HSSE CF).

2. Objectives
The objective of the HFE Screening workshop is to prepare an appropriate HFE Strategy for the project. The HFE Strategy shall:

- Identify the HFE-specific standards or technical guidance to be included in the selection of engineering design standards for the project.
- Identify the key HFE design studies or analyses and HFE assurance activities required in the current and subsequent phases of the project
- Define the HFE resourcing and organizational requirements necessary to ensure effective implementation of HFE in the current and subsequent phases of the project.

The HFE Strategy must be incorporated by reference into the Basis for Design as well as the Health Management Plan for the project, and into the contractual requirements for front-end engineering or detailed design, as appropriate.

3. Agenda
An example agenda for the HFE Screening workshop is as follows:

- Introduction
- HFE Awareness presentation
- Project background and objectives
- Team discussion
- HFE Strategy for project
- Wrap-up

4. Preparation
Prior to the HFE Screening session, the attendees will be asked to read through this DEP Specification. When available, the following documents will also be provided:

- Draft Basis for Design/ Selection Report
- Preliminary Equipment List
- HAZID report
- PFDs and/or P&IDs
- General Arrangement or Plot Plan
5. Attendees

Success of the HFE Screening is largely dependent upon attendance on the appropriate personnel. Those required to attend should include:

- Project Manager/Design Integrator
- Project or Discipline Engineers
- Construction Management
- HSSE Lead and/or Technical Safety representative
- Operations and Maintenance (or Operations Readiness) representatives
- Facilitator (HFE TA)
APPENDIX 3 TASK REQUIREMENTS ANALYSIS

Task Requirements Analysis (TRA) is a technique developed to quickly analyse task steps in order to identify particular, necessary design requirements.

By using operational and maintenance experience, and drawing on available project information (such as draft PEFS or P&IDs) as an input, TRA seeks to identify tasks that are expected to be complex, particularly time consuming or difficult, potentially prone to human error or where people will be exposed to health or other hazards.

Once identified, specific design requirements are identified to resolve potential problems or difficulties, or to take advantage of opportunities to improve the efficiency or effectiveness of human activities. The results are captured in a standardized report and table format.

As the analysis is intended to capture design requirements, and may impact plot plan layout, and/or a Vendor’s scope of supply, it should be carried out as early as is feasible during DEFINE, before the 10% estimate and before the final specification for the equipment.

Facilitating Task Requirements Analysis is a skilled activity and requires at least skilled level HFE competence.
APPENDIX 4  TERMS OF REFERENCE FOR A MATERIAL HANDLING STUDY

What
A material handling study is a systematic analysis, design and review during the detail engineering phase of a project. A material handling study will help determine how material/equipment/components that are above the manual handling limits, will be handled (lift/lower, transport and appropriate lay down area) during the life of the facility.

Why
- Ensure that assisted (Mechanical) lifting devices are provided for or considered during design phase for all equipment or components that weigh in excess of 46 kg (100 lbs) to prevent back or other muscular-skeletal injuries from occurring during maintenance activities.
- Systematic study ensures O&M is involved and appropriate material handling strategies are adopted and fit for purpose equipment is selected/procured.
- Report provides a record for future use by the site/asset when conducting maintenance activities to ensure that they are operating within the original design envelope with regards to equipment and structural loading.
- Results could also be used as input to improve constructability and construction safety.

How
Consider the following:
- Identify and list all material/equipment/components to be “handled” e.g., turbines, valves, filters, tube bundles, pumps, catalyst, etc. as well as their size (dimensions) and weight.
- Determine frequency of maintenance and broadly categorize, e.g., frequent (more than once a year, every 1-2 years, or once or twice during life of facility.
- Determine criticality, e.g., production impact or safety critical equipment?
  - Yes
  - No
- Based on health and safety, frequency of maintenance and production impact, determine appropriate Strategy, i.e., equipment to;
  - Lift/lower
  - Transport
  - Suitable or designated lay down areas
- Review design with ORA (Operations & Maintenance), HSSE and HFE either using 3D model or suitable structural drawings and other product details and obtain their approval.
- Develop list of material handling equipment to be procured/supplied by the project.
- Include in a brief report.

Who
- Typically conducted by EPC (Mechanical and Structural Engineering)
- Reviewed by Shell (OR, HFE and HSSE)