

DEP SPECIFICATION

HUMAN FACTORS ENGINEERING – CONTROL ROOM DESIGN

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP sets out the minimum requirements for application of the principles of Human Factors Engineering in the design and development, including change and upgrade, of control suites, control rooms and related operator workstations.

This DEP, therefore, does two things:

- It defines a minimum level of human factors engineering analysis activities to be applied to the process of specifying, developing and validating control suite, control room and related operator workstation designs;
- It provides the minimum HFE technical requirements that a project shall apply to the design and validation of control suite, control room and related operator workstation designs.

These requirements are intended to ensure that Project teams (and their Contractors and Vendors) apply good practice in developing control rooms that support high levels of usability and situation awareness among panel operators and others who have to monitor and control complex automated systems in process-related facilities. Compliance with ISO 11064 will also satisfy this DEP.

This DEP addresses the “hardware” aspects of control suite, control room and related operator workstation design. The design of on-screen Human Machine Interface (HMI) is addressed in DEP 30.00.60.16-Gen.

This is a revision of the DEP of the same number dated February 2012; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall 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 with regard to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP 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, the objective being to obtain agreement to follow this DEP 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, authorized to act for, and on behalf of the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Control Building	The building or module that contains the control suite.
Control Room	Core functional entity, and its associated physical structure, where operators are stationed to carry out centralized control, monitoring and administrative tasks.
Control suite	Group of functionally related rooms, co-located within a building which includes the control room, and houses the direct functions supporting the control room.
Controlled system	A process unit, plant or production facility, pipelines, tank farms, supply and distribution terminals, etc.
Control console	Structural framework which supports equipment, work surfaces and storage and which together comprises a control workstation.
Control panel	Discrete surface on which groups of displays and controls are mounted; control panels may be mounted on the control workstation or on walls.
Display	Device for presenting information that can change or a software component that determines the spatial format and layout of visual outputs of the human machine interface on the hardware elements referred to in this DEP as screens.
HFE Authorised Person	A person authorised and assigned responsibility to develop and approve procedures for HFE. An HFE authorised person has proficiency assured at skill level and is accredited at a professional level in HFE
HFE Technical Authority	Individual responsible for quality assurance of HFE work performed on a project.
Human-Machine Interface	The combination of software and hardware elements that determines the nature of human interactions with equipment and people in the workplace through command inputs and data outputs.
Panel/Control Room Operator	An individual who fulfils their work obligations, whether full or part-time, by interaction with a process control system. Panel/Control Room operators are usually provided with workstations comprising a combination of screens, work-surfaces, a chair and associated devices (such as phones, radios, and keyboards).
Screen	A hardware component that supports viewing the visual outputs of the human-machine interface.
Situation Awareness	The mental state of being aware of what is happening around you and the associated understanding of what that means now and in the future relative to a particular job, function or goal.
Task analysis	Systematic breakdown of work tasks into their elements, including a description of both manual and mental activities, task durations, task frequencies, task allocation, task complexity, environmental conditions, equipment, and any other unique factors involved in or required for one or more human beings to perform a given task.

Term	Definition
Task, work task	An activity required to achieve an intended outcome of the work system.
Usability	The property of a human machine interface that is measured in terms of its ease of use, learnability, efficiency, and error tolerability.
Validation	The process of determining the extent to which a system meets its requirements.
Work environment	Physical, chemical, biological, organizational, social and cultural factors surrounding a person in his or her work tasks.
Work station	Combination of work equipment in a work space, including the work environment, where one or more work tasks have to be carried out by a person. NOTE: It is possible that several persons share a specific work station, or that several persons alternate work stations within any period of time (i.e. hourly, daily, weekly).

1.3.3 Abbreviations

Term	Definition
CR	Control Room
CRT	Cathode ray tube
DCS	Distributed Control System
FRC	Fire-resistant clothing
HFE	Human Factors Engineering
HMI	Human-Machine Interface
HVAC	Heating, Ventilation and Air Conditioning
LCD	Liquid Crystal Display
LQ	Living Quarters
P&ID	Piping and Instrumentation Diagram (equivalent to PEFS)
PEFS	Process equipment flow sheet (equivalent to P&ID)
SCADA	Supervisory Control and Data Acquisition
TA	Technical Authority
TRA	Task Requirements Analysis
UPS	Uninterrupted Power Supply
VDU	Visual Display Unit, i.e. a cathode ray tube (CRT), liquid crystal display (LCD), plasma panel, and other screen or visual display device

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2012. The change in this revision are extensive and too numerous to list here however the primary work has been to restructure and clarify requirements, enforced use of shall / should / may for normative statements

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. CONTROL SUITE DESIGN DEVELOPMENT PROCESS

1. The design scope for the development of onshore control suite/room shall adhere to the architectural stages as referenced in section 8 of DEP 34.17.10.32-Gen.
2. The schematic architectural preliminary scope of services and deliverables for onshore control rooms and the design development for offshore control rooms, shall include a HFE analysis that consists of the following:

- a. Functional and role analysis;

- i. All the functions expected to be integrated into the control suite/room shall be identified along with the related facilities and equipment necessary to support them;
- ii. The roles expected to be involved in performing or supporting those functions shall be identified;
- iii. The analysis shall be delivered in a Function-to-Role matrix;

- 1). Refer to (Appendix A, Figure A.1) for the format such a matrix might take;

This analysis will define who the primary and secondary end users in the design of the control suite and control room are.

- 2). Primary users should have all of their functional needs identified in the analysis met.

Secondary user needs can be compromised if necessary to optimise the design for primary users.

- b. Task Requirements Analysis (TRA);

- i. A TRA of each of the roles identified as being primary users of the control room shall be performed which identifies;
 - 1). Main role/responsibility;
 - 2). Key high level tasks for each role;
 - 3). Equipment and other facilities needed to support each key task;
 - 4). Who needs to be communicated with in performance of each key task;
 - 5). Performance standards for key tasks (i.e. the conditions that are essential to be able to do the tasks safely and efficiently).

Refer to (Appendix A, Figure A.2) for the format of how TRA results may be presented.

- c. Functional relationship and adjacency analysis;

- i. For all identified functions, roles (primary and secondary) and equipment, a Functional Relationship and Adjacencies analysis shall be performed using the following criteria;
 - 1). Low Low (LL);
 - 2). Low (L);
 - 3). Medium (M);
 - 4). High (H) and;
 - 5). High High (HH).

Refer to (Appendix A, Table A.1, Figure A.3, and Figure A.4) for how the format of Functional Relationship and Adjacencies analysis results may be presented.

3. As part of the scope of services and deliverables for the design development stage, the Contractor shall produce a control suite layout that includes all primary workstations with key equipment and facilities.

3. CONTROL BUILDING DESIGN REQUIREMENTS

3.1 LOCATION (PLOT PLAN)

The location of the control building (building) is mostly determined by non-HFE factors such as safety, blast modelling, wind direction, desired free space around the building, potential for expansion, emergency response, type and number of plants/units that are to be controlled from the control room.

Locating the control building near to the plant/unit, has the benefit of operations and other functions being in closer contact with plant/unit with shorter movement distances. The disadvantage is potentially increased civil engineering costs due to safety (facility siting) constraints.

Locating the control building some distance from the plant/unit, has the benefit of being less subject to plant noise and odours, increased feeling of safety and lower civil engineering costs.

1. The design and layout of the building shall include features that discourage the use of undesirable routes to and from the control building.
Undesirable routes include short cuts using emergency exits or walking through the control room).
2. The location of the control building should permit easy access to all areas that might need to be visited on a regular basis.
3. If a process or site/area is required to be visible to particular operators from within the control room, then control work area or station within the control suite should be located and the building designed so that visual monitoring/observation is unobstructed and the area is provided the required lighting.
4. Contractor shall provide documents that demonstrate how the following are managed in relation to the chosen location, layout and orientation of a control building:
 - a. user task interaction with equipment (2, Item 2);
 - b. space for service and maintenance activities;
 - c. space for movement of operators, other personnel and visitors.

Refer to DEP 34.17.10.32-Gen. for additional building location requirements.

3.2 TRAFFIC, ROUTING AND ENTRANCES

1. Access to the control building shall include facilities and features that enable movement of equipment as well as personnel.
2. Doors and passageways internal to the control building shall enable access and transport in case of expansion, replacement or moveable equipment housed therein.
 - a. Contractor shall provide a list of equipment or equipment components that are not termed expansion, replaceable or moveable to Principal for review.
 - b. Lifting facilities and aids and transport facilities and aids shall be provided to facilitate movement of equipment.
3. Contractor shall comply with accessibility legislation (i.e., governing access by mobility impaired users) appropriate to the location of the control building.
4. Contractor shall provide documents that demonstrate that the design and layout of the control building:
 - a. facilitates movement of personnel during peak traffic times (i.e., shift handovers and other meetings);
 - b. meet the requirements for special security checks at portals that control access to the control suite;
 - i. any restrictions placed on access for unauthorized personnel should not impede access for authorized personnel.

A typical security feature is control by means of a key-card.
5. The design documentation shall demonstrate how future extensions of equipment and to maintenance and replacements, which might require access through the floor or ceiling/roof are planned and/or managed.
6. The design shall provide access to first aid equipment, emergency equipment and emergency exits in accordance with local regulations.

3.3 FUNCTIONAL AREAS, LAYOUT AND FUNCTIONAL REQUIREMENTS

1. Training and simulator facilities shall be based on a structured training needs analysis to determine training objectives and thus facility design requirements.
 - a. The structured analysis shall be subject to the approval of the Principal.
2. The design may consider providing an exercise facility/area or an Alertness Recovery Room either adjacent or in close proximity to the control room.

Exercise equipment, such as a treadmill, stationary bicycle and another small piece of cardio vascular equipment, can be considered for maintaining operator alertness.

 - a. Alertness Recovery Room may be combined with the Hurricane Relief Room where one is provided.

Alertness recovery rooms have been implemented in some facilities with the aim of sustaining the alertness levels of control room operators during night shifts and reducing the risk of fatigue.
3. An Alertness Recovery Room shall not be:
 - a. considered a replacement of the requirement to ensure shift structures and working hours provide minimal risk of operator fatigue and ensure adequate sleep opportunity;
 - b. utilized without an acceptable Fatigue Risk Management Plan in place at the site.

A Fatigue Risk Management Plan used to justify An Alertness Recovery Room is to be approved by all appropriate parties (e.g., Management, Operations/Production, and Health & Safety).
4. An Alertness Recovery Room should include a recliner as well as suitable lighting and noise control to facilitate undisturbed sleep/nap for a maximum 20 minute period.
5. For assets subject to risk of hurricanes or typhoons, a Hurricane/Typhoon Relief Room (or alternative suitable accommodation) with bunk beds and recliner chairs shall be provided for the purpose of accommodating all control room staff not able to vacate the site due to hurricane/typhoon or other extreme weather conditions.
6. A vending machine area should be provided or integrated with kitchen facilities when specified.
 - a. The quality of the vending machine area is subject to approval by the Principal.
7. Dining hall/cafeteria may be sized to include an assembly area for temporary refuge.

It may be necessary in a large control building to provide an assembly area (temporary refuge).
8. Restroom/toilets, washing and changing rooms should be located in close proximity to the control room.

9. The Restroom/toilets, washing and changing rooms facilities shall be adequate for the expected peak number of people (including shift change and maintenance turn-around activities), and suitably sized to represent the male and female composition of the workforce.
 - a. Refer to DEP 34.17.10.32-Gen. for the required facilities.
 - b. Separate male and female locker/change rooms shall be provided.
 - i. Designs should consider providing capability to change the ratio between male/female locker requirements as demographics may change in the future.
 - ii. At small facilities (accommodating less than, nominally, 10 people), male and female locker room may be combined if separate restrooms are available that allow adequate privacy for changing and personal cleanliness.
 - iii. Facilities in the locker rooms shall be designed and installed to accommodate the extensive clean-up that may be required during operational maintenance and turn-around activities.
 - iv. The layout shall address providing storage for incoming, clean FRC clothing in locker rooms and separating and drying out of "dirty" or wet gear/boots due to wet/muddy/snow conditions outside.
10. Showers shall be provided if showering facilities are not provided elsewhere in the facility or if:
 - a. the operation is particularly dirty, or
(example of particularly dirty operations is the oil sands facility)
 - b. staff may be exposed to rain, dust, air-borne chemicals and other severe weather conditions.
11. Conference/meeting room(s) shall be provided for meetings and training.
 - a. At least one conference room should be located adjacent to the control room.
 - b. Storage for audio-visual equipment shall be provided inside the conference/meeting room.
12. To avoid disruption/distraction of panel operators in an emergency, the design and layout should segregate the emergency response or incident command team area from the control room to avoid the emergency response/incident command team congregating inside the control room.
 - a. If emergency response or incident command team area is adjacent to the control room, then it should be separated by a door that can be closed.
 - b. Where it is not practical to provide a separate area where major incidents can be handled, the provision of extra vertical display and horizontal work surfaces shall be provided inside the control room for the presentation or viewing of PEFS/plant layout, maps, charts, or procedures (e.g., white boards for event logging and tracking and table tops for PEFS/layout drawings).
 - i. The layout shall accommodate this extra staff in emergencies.
13. Audio and visual technology for the control room and emergency response or incident command team room shall be determined based on an assessment of the task and communication requirements.
 - a. The derived task and communication related IT hardware, audio and visual technology equipment requirements shall be approved by the Principal.
 - i. Contractor shall liaise with project and local IT representatives during project planning and design for specific IT and hardware guidance.