

HUMAN FACTORS ENGINEERING – HUMAN MACHINE INTERFACE DESIGN FOR SITUATION AWARENESS

DEP 30.00.60.16-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies Human Factors Engineering (HFE) quality control requirements and gives recommendations for the design of Human Machine Interfaces (HMI) in process control systems.

These requirements and recommendations aim at the development of HMIs that support high levels of usability and situation awareness among panel operators and others who rely on HMIs for awareness and control.

This DEP should be read in conjunction with other HFE DEPs in the 30.00.60.xx series. In particular, this DEP shall be used in association with DEP 30.00.60.10-Gen. and DEP 30.00.60.15-Gen.

There are several examples in the appendices of this DEP that use colour to illustrate effective or ineffective design techniques. This DEP should therefore be viewed with a colour monitor or as a colour printout.

This DEP is a revision of the DEP of the same number dated April 2006; 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.

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/distribution 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 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 **Vendor** 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

Action	The process initiated when an operator invokes a command on the HMI, for example by selecting a menu option, or action button. Sometimes supported by a double mouse-click. In some cases, the act of selecting an object also implies actioning it (e.g. where selecting a display name opens that display).
Area of Control	The process areas, including equipment and any other facilities or resources which define the scope of responsibility of an individual panel operator role.
Display	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 document as screens.
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 Operator	An individual who fulfils their work obligations, whether full or part-time, by interaction with a process control system. Panel 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.
Select	The process by which an operator indicates an on-screen object or element without invoking any command other than on-screen functionality. For example, selecting an on-screen icon will often open a menu or change a display.
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.
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.

1.3.3 Abbreviations

ASM	Abnormal Situation Management
ESD	Emergency Shut-Down
ESP	Ensure Safe Production
FAT	Factory Acceptance Test
FEEEM	Front End Ergonomics Evaluation Matrix design analysis
GAME	Global Asset Management Excellence
HFE	Human Factors Engineering (synonymous with "Ergonomics")
HMI	Human-Machine Interface
SA	Situation Awareness
SAT	Site Acceptance Test

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 by this DEP are listed in (5).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated April 2006. This has been a total rewrite and it is therefore impractical to summarise the changes here.

1.6 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).

2. AIMS AND BENEFITS – THE ROLE OF THIS DEP

2.1 THE NEED FOR SITUATION AWARENESS

Panel operators need to be able to perform their tasks pro-actively, detecting and responding to abnormal situations (including deviations from planned production as well as potentially unsafe situations) before they lead to incidents or production upsets. This contrasts with operators performing re-actively, largely in response to alarms.

Achieving pro-active operator performance requires the HMI to have at least the following features:

- That it is easy to use. It shall make minimal demands on the panel operator to understand and interact with the process control system. i.e. the HMI shall allow operators to concentrate on controlling the process rather than interacting with the DCS system.
- That it allows operators to develop and maintain a high level of real-time awareness of the state of the process, while also allowing them to work at a detailed level with individual process units and equipment.

Combined, these two features are addressed by this DEP under the overall term 'Situation Awareness' (SA). Appendix 1 provides a brief overview of the scope of SA, based on recent scientific thinking.

2.2 PURPOSE OF THIS DEP

In common with most large software applications, modern process control systems provide a 'tool-box' of basic HMI components. Individual projects draw on this 'tool-box' to design and build the specific HMI displays and functionality needed for a particular application.

While there is a high degree of commonality between the HMI tool-boxes offered by different suppliers, there are also important differences. These differences reflect the capabilities of different systems as well as the vendors' preferred 'look and feel' of their systems. Table 1 illustrates typical 'tool-box' components, indicating the degree of control an individual project can usually expect to have over how these elements are put together to create their HMI.

The major DCS vendors' HMI tool-boxes usually provide all the elements and functionality required to build an HMI that delivers high standards of usability and situation awareness. They do not however guarantee an acceptable design: the tool-boxes are as capable of being used to develop poor quality HMIs, as high quality ones. There are, for example, recent cases where the same version of the same DCS system, using the same HMI tool-box, has led to completely different HMI designs, even within the same site.

This DEP does two things:

1. It defines a minimum level of quality control to be applied to the process of specifying, developing and validating HMI designs, where usability and operator situation awareness can be critical to process safety and/or production; and
2. It specifies the minimum technical requirements to be applied to the design and validation of HMIs to ensure high levels of usability and situation awareness.

The process and requirements specified in this DEP recognise that the level of HMI quality control needed depends on the complexity and criticality of the [particular application].

Table 1 Summary of the influence a project might have over how the elements of an HMI ‘tool-box’ are used to develop a project-specific HMI.

HMI tool-box elements	Typical degree of influence	Notes
Colour palette	Moderate	Projects can usually specify required colours (up to a pre-defined maximum).
Colour usage	High	Projects will probably have nearly complete freedom over how the colours in the colour palette are used. (Though note that this DEP provides guidance information coding requirements, including use of colour).
Dynamic symbols	Low	Most tool-boxes come with a pre-defined set of dynamic symbols (e.g. valves, pumps, indications, and bar graphs). These display objects have pre-defined behaviours when selected or actioned.
Non-dynamic symbols	High	Projects can usually define a set of project-specific symbols. These symbols will usually be static, and will not change as a result of operator action.
Alarm Systems	Low	The functionality provided to support alarm management is usually highly structured. However, there is usually a lot of flexibility over how alarms are prioritised and configured within the overall structure. (Note that, the ESP Initial Setup (ISU) work process sets alarm priorities).
Fonts and text	High	Projects will probably have a lot of freedom to define font style, size, colours and text.
HMI object behaviour	Low	Chosen system usually constrains how on-screen elements ‘behave’ (i.e. what happens when they are selected or actioned).
Toolbar	Low	Toolbar icons are usually pre-defined
Display hierarchy structure	Low	The basic display hierarchy is usually pre-defined in terms of the numbers of levels in the hierarchy, the relationship between the levels, and the possible behaviours at each level.
Display hierarchy content	Moderate	There is usually a high degree of control over the content – i.e. what is actually displayed at any level of the display hierarchy. Note that control loops, equipment and valves not directly controlled by the DCS will not normally be represented on screen graphics unless they are specifically requested).
On-screen icons	Low	Selectable control icons usually pre-defined. Possibly some control over the use of colour, text.
Method of operator data input	Low	Direct interaction with data in fields usually only possible within equipment face-plates. Direct interaction with on-screen process values is not usually possible.
Size and behaviour of face-plates	Low	Should be able to influence contents of face-plates (layout, labels, data fields, bar-graphs), but not how they behave.

2.3 PRINCIPLES

This DEP is based on the following principles:

- Apply the learnings and state-of-the-art guidance developed by the Abnormal Situation Management® consortium.
- Balance reliance on DCS vendor experience with clear HMI design requirements and quality control over the HMI development process.

The purpose of this DEP is not to unduly constrain vendor experience or capability. Rather it is to define a minimum degree of control, direction and consistency in how different vendors systems are used to develop HMIs. This is based on both industry best-practice, as well as experience of where there has been lack of adequate control in the past. The aim is to ensure quality and consistency of HMIs that meet the requirements for process control (as defined for example by the GAME ESP processes).

- Maximize the integration of HMI development with the overall HFE Process, including making most efficient use of time and resources, and re-use of existing design analysis and other material.

2.4 COLOUR DESIGN

This DEP does not attempt to define recommended colour coding to be used in HMI design. There are three reasons for this;

1. Different businesses and facilities have different experiences in the way colour has been used in existing HMIs. For example, some businesses have a history of using colour to code process flow lines, while others do not colour code process lines. It is usually important to retain and make use of such site-specific experience and preferences.
2. Colour design shall be optimised and balanced against the background colour and luminance, as well as control room lighting environment. Again, different facilities have different experience and preferences for background colours, luminance and lighting environments. It is not technically sound to specify colour in isolation from these other factors.
3. There are differences in alarm management policies both between DCS packages, and between different businesses (e.g. some sites have 3 levels of alarms, while others use 5).

This DEP therefore defines the underlying usability and situation awareness requirements that shall be met whatever colour design solution is implemented. Section 3.2.2 specifies that critical HMI development projects specify colour and other HMI design coding requirements before a DCS vendor is appointed.

Further guidance on the use of colour in the design of DCS HMIs can be found in Section C.6. of the Abnormal Situation Management® Design Guidance 'Effective Operator Display design, version 6, Dated December 2008.

3. HMI DEVELOPMENT PROCESS

3.1 INITIATION

This process shall be initiated as part of the HFE screening conducted during Front End Engineering (as required by DEP 30.00.60.10-Gen., and in compliance with Shell Health Management Standards and the HSSE Control Framework). The HFE Screening shall determine:

- Whether this DEP shall be included in the project baseline, and, if so,
- The level of quality control to be applied to the HMI design.

Figure 1 shows the decision tree to be used to screen projects for these two factors.

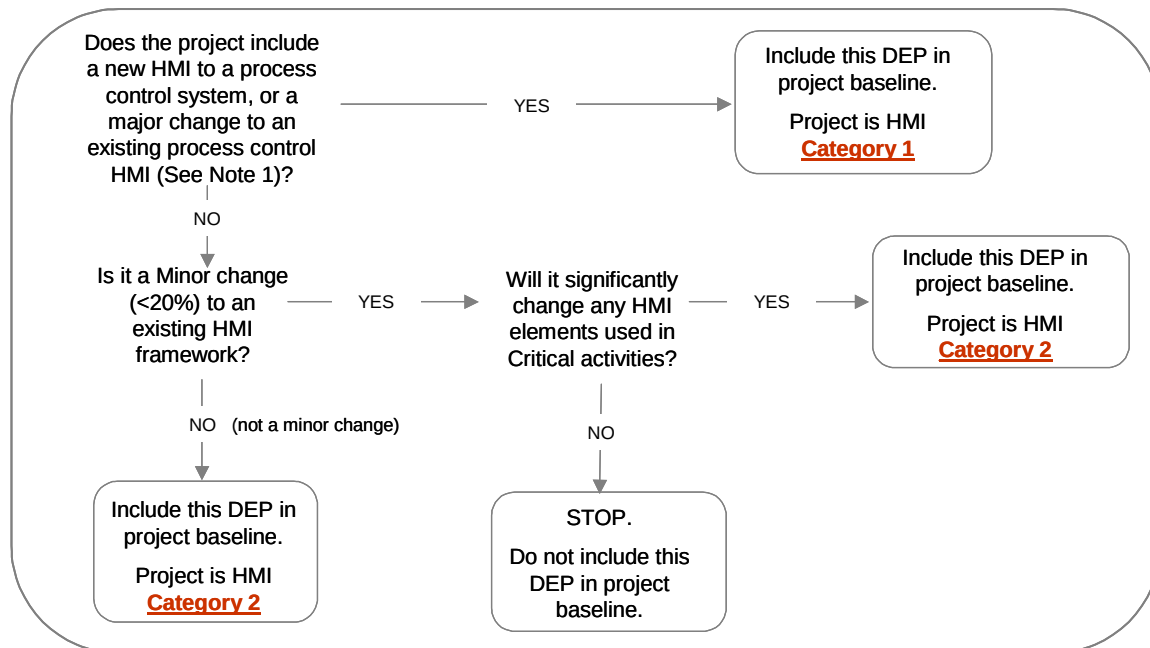


Figure 1 Decision tree for deciding whether to include this DEP in project baseline

- NOTES:
1. As a guide, a 'major change' is a project in which:
 - one or more new workstations will be introduced; or
 - more than 50 % of the existing displays will be changed; or
 - the number of new displays to be introduced will exceed 50 % of the existing total.
 2. As a guide, a 'Minor change' is a project in which:
 - changes will affect operator interaction with fewer than 20 % of the existing displays; AND
 - the number of new displays will be less than 10 % of the existing total; AND
 - the changes will be implemented in the same software system and version as the existing HMI.
 3. 'Critical' activities include:
 - startup or shutdown of process units;
 - communications, including shift-handovers, start-of-shift-orientation, shift team meetings;
 - proactive monitoring of process units;
 - performance of tasks that are known to be particularly difficult, time-consuming, stressful, or that may be carried out over extended periods;
 - execution of activities identified in Safety Critical Elements or shown as barriers in Bow-Ties at the asset (including responding to alarms).

Projects identified as HMI Category 1 shall follow the development process defined in (3.2). Category 2 projects shall follow the process in (3.3).

3.2 CATEGORY 1 HMI PROJECTS

3.2.1 General

Figure 2 summarises the HFE quality control activities required for a Category 1 HMI development project (i.e. projects involving development of new DCS HMIs or a major change to an existing system).

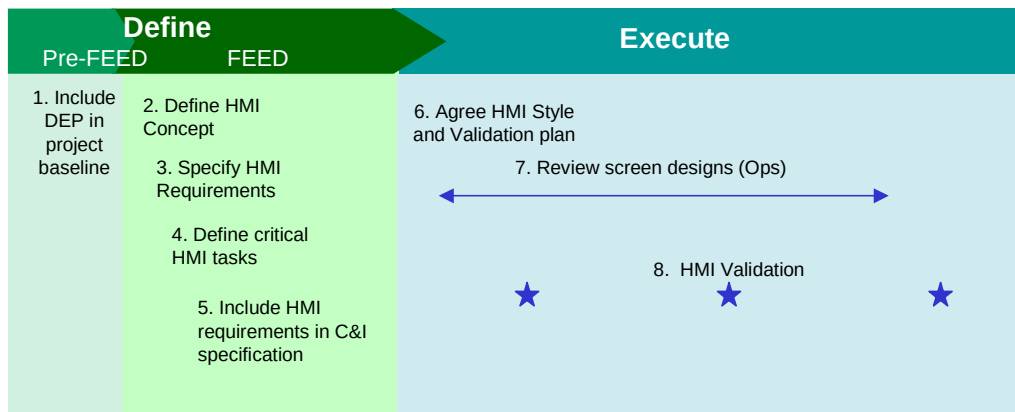


Figure 2 HFE quality control activities for Category 1 projects

3.2.2 Activities to be conducted during DEFINE

The following activities shall be completed before the end of the FEED phase.

The purpose of these activities is to ensure that HMI requirements are adequately specified and that they are included in the contract baseline for the selected DCS vendor. These activities ensure the HMI requirements included in the C&I specification meet the specific needs of the asset.

1. Include this DEP in project baseline

For projects identified as HMI Category 1, this DEP shall be included in the list of DEPs in the project baseline.

2. Define HMI baseline and concept

The project team shall prepare a short description clearly describing the assets current situation and expectations of the HMI. This description should not be more than two pages in length and **shall** cover:

- Who will use the system (the number of roles and individual operators, and an indication of their prior experience with DCS systems – both years and different systems used);
- Other HMI systems these operators will be expected to interact with during normal, startup/shutdown, upset or emergency situations, indicating their relative importance to process safety and production;
- A summary of specific HMI tasks or situations at the facility that are known to be demanding, difficult, stressful, time-consuming or prone to human error in interacting with the existing HMI;
- A short 'vision statement', in as specific terms as possible, describing the operators expectations of the new HMI. This statement should also describe anything they would expect not to have to do using the HMI. Appendix 3 contains an example illustrating the form such a vision statement might take.

The HMI baseline has no formal status as a requirement. Its purpose is to provide a point of reference and challenge in specifying, and reviewing the developing HMI as the project goes forward.

3. Specify HMI design requirements

A specification of HMI requirements shall be developed. This requirements statement shall be based on a review of Section 4 of this DEP (and the related Appendices 4 to 9). As a minimum, the specification shall include:

- a) Either a statement that all of Section 4 shall be adopted as HMI design requirements, OR
A list of specific requirements from Section 4 that shall be treated as contractual for the project, OR
Reference to an alternative International, industry or other approved standard for HMI requirements for Process Control applications that shall be adopted as specifying the project HMI requirement.
- b) A definition of the preferred colour and luminance of the background to be used for all process displays. (Note: This definition can be qualitative: it does not need to be specified in colour co-ordinates or units of luminance).

In addition, the HMI Requirements specification shall define:

- c) The information elements to be displayed in the HMI that are considered as Priorities 1 to 5 in terms of importance for capturing visual attention (with Priority 1 being highest). (See section 4.3 and Appendix 5 for more information on information priorities)
- d) The preferred information coding techniques to be applied to Priority 1 to 5 items (See section 4.3)
- e) Requirements for cognitive compatibility of the HMI with:
 - Other HMI systems that panel operators are expected to use;
 - Other operators or plant personnel that each panel operator needs to communicate with using information derived from the HMI.

The need for cognitive compatibility shall include consideration of, for example, measurement units, terminology, abbreviations, use of colour and other information coding techniques, as well as alarm appearance and behaviour.

NOTE: The term "cognitive compatibility" refers to consistency between the way information used in mental operations (decision making, calculations, comparisons, etc) is displayed on an interface, and the way the intended user is likely to mentally represent or think about that information. This will often depend on the operators' prior experience and training.

- f) Any other feature of the HMI appearance or functionality that operations consider critical to the acceptability of the HMI design.

4. Define critical operator tasks

The project shall define a sample of operator tasks considered to be critical and demanding of the HMI for each of the operator roles to be supported. Critical tasks shall be selected based on consideration of:

- The consequence of human error for process safety or production.
- The frequency of performance of tasks that require interaction with the DCS system

NOTE: Critical tasks performed very infrequently can be particularly prone to error due to lack of familiarity and experience. Non-critical tasks, if performed very frequently, can be considered as HMI critical – so shall be very easy to perform.

- Expectations about the mental difficulty of performing tasks, the amount of sustained attention or concentration likely to be required, or the amount of information that an operator might need to remember in order to perform a task.

- Any other tasks operators consider especially important in using the HMI.

Critical tasks only need to be defined at a high level. There **shall** be sufficient description to be clear about the situations in which they might need to be performed, which operator roles would be affected, which process units or equipment, and why the task is considered critical.

Critical task descriptions should specify any potential performance measures or other indicators that would reflect how well the task has been supported by the HMI design. Examples of performance measures might include:

- the maximum allowable time to perform a task;
- the number of actions or key presses to move from one display to another;
- the time to locate and change an equipment set point;
- the frequency of misreading tag numbers, etc.

Examples of other types of measures include:

- the ease of relating face-plates to equipment symbols;
- avoiding the need for mental calculations or having to remember process values.

The task definitions will provide a baseline for review and consideration of the developing HMI. They also provide the basis for usage scenarios for design and usability testing during the EXECUTE phase.

5. Include HMI requirements in project specification

The HMI requirements and critical task list shall be included as a stand-alone section in the HMI or Control and Instrumentation specification for the project and shall be referenced in tender material used to select a DCS vendor.

The HMI baseline and concept shall be made available to the DCS vendor for information.

3.2.3 Activities to be conducted during the EXECUTE phase

The following activities shall be completed during the EXECUTE phase for a project where the HMI project development is identified as Category 1 (see Figure 1).

These activities ensure an appropriate level of visibility, structure and control over the DCS contractors' HMI development and validation activities.

6. HMI Style and Validation Review

As soon as possible after a DCS vendor is contracted, a review meeting shall be held with the following objectives:

- Ensure the vendor understands the HMI requirements and identify any potential issues.
- Review the vendor HMI Tool-box, identify areas where project-specific customisation is required or possible, and define a plan for producing the customisation.
- Review the specified background colour and luminance, and information prioritisation and coding policies and review how they will be implemented.
- Agree on the policy for mapping P&IDs or other process specifications to display mapping.
- Review the critical task list and identify any potential issues or tasks requiring clarification.
- Agree to the process for operator involvement in reviewing and approving display designs. Consideration shall be given to the use of 'operator walk-throughs' of

critical task using simulations or emulations as early as possible in development process.

- Agree the programme of HMI validation, including usability testing and HMI proving in FAT (see Appendix 2).

Any changes to the HMI requirements arising from this review shall be subject to formal change control and approval. The objective is to balance the HMI requirements identified during FEED with what is technically and financially feasible given any HMI constraints imposed by the selected DCS vendor.

Following the meeting, the vendor shall develop a sample of prototype displays illustrating the key elements of the HMI (use of colour, information coding, font type and size, etc). The display prototypes shall be reviewed by the Shell project team to determine whether any changes to the proposed HMI style are required.

7. Review display designs

Shell operations representatives shall provide support to the vendor in reviewing and approving display designs. This activity includes reviewing the content, layout, and information coding of each static display. Opportunities to review techniques for interacting with the HMI displays as well as the dynamic behaviours of the display objects shall be identified.

8. Usability validation

Validation of the HMI for Category 1 projects shall involve two components:

- Informal usability testing (See Appendix 2 for guidance).
- A formal HMI demonstration as part of the FAT programme.

The Usability Validation (test) Plan shall be agreed during the HMI Style and Validation Review (Task 6). The plan shall define the expected general approach, the personnel and resource requirements, and the number of tests to be conducted.

Appendix 2 provides general requirements and guidance on the conduct of usability validation activities.

The FAT HMI demonstration is the formal point of agreement that the HMI has met the requirements specified during DEFINE, as modified by any agreed changes during EXECUTE.

3.3 CATEGORY 2 HMI PROJECTS

3.3.1 General

Figure 3 summarises the HFE quality control activities required for a Category 2 HMI development project. (Category 2 projects involving significant change to existing HMI, or change to existing HMIs supporting critical activities).

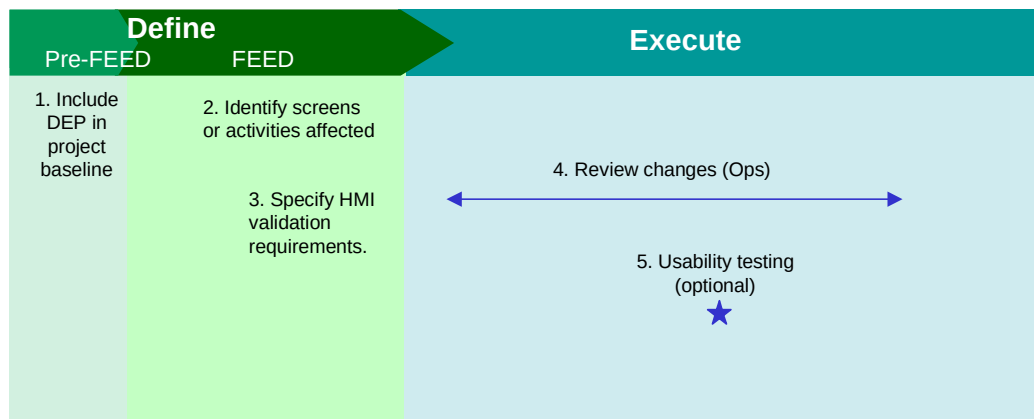


Figure 3 HFE quality control activities for a Category 2 HMI project

3.3.2 Activities to be conducted during DEFINE

The following activities are required to be completed before the end of DEFINE phase for a project where the HMI content of the project is identified as being Category 2 (see Figure 1).

The purpose of these activities is to ensure that HMI scope, requirements and validation methods are adequately defined prior to beginning the Execute phase of the development.

1. Include this DEP in project baseline

For projects identified as HMI Category 2, this DEP shall be included in the list of DEPs in the project baseline.

2. Identify and assess risk associated with displays or activities affected

During DEFINE, the project shall review the reasons why the HMI change was assessed as Category 2:

- Because it involves significant change to an existing HMI framework (see section 3.2, note 2), or
- It will affect the HMI for operator activities assessed as being critical (per section 3.2, note 3).

In either case, the project shall identify the specific displays and/or critical activities likely to be affected, or created by the project.

For each of the identified displays and/or affected critical activities, the project shall estimate the associated risk to process safety, production and operator workload if the HMI does not achieve an adequate level of usability and/or situation awareness support. This risk assessment shall include input from experienced operations representatives.

3. Specify HMI design requirements

Based on the risk assessment in Activity 2, the project shall decide whether there is a need to define project-specific HMI requirements.

The following shall be considered:

- Including a statement in the Control and Instrumentation Specification that all of Section 4 shall be adopted as HMI design requirements, OR
- Producing an extract from Section 4 listing those specific requirements that shall be treated as contractual for the project, OR
- Referring to an alternative international, industry or other approved standard for HMI requirements for Process Control applications that shall be adopted as specifying the project HMI requirement.

If any additional HMI requirements not covered in Section 4 are considered necessary, these shall also be included.

The requirements identified shall be specified in the Control and Instrumentation specification or another suitable project document.

4. Specify HMI validation requirements

Based on the results of activities 2 and 3, the project shall specify the level of Validation required during EXECUTE to demonstrate that the HMI is acceptable. Three levels of HMI validation should be considered for HMI Category 2 projects (any combination of these levels can be used):

- a) A review of the new or changed HMI elements by operations representatives.
- b) Informal usability testing (see Appendix 2 for guidance).
- c) A formal HMI demonstration as part of the FAT programme.

3.3.3 Activities to be conducted during EXECUTE

The following activities are required to be completed during the EXECUTE phase for a project where the HMI project development is identified as being Category 2 (see Figure 1).

5. Review changes

Operations representatives shall provide support to the vendor in reviewing and approving changed or new display designs. As a minimum, this shall include reviewing the content, layout, and information coding of static displays.

Opportunities for operations to review the techniques for interacting with the HMI displays as well as the dynamic behaviours of the display objects shall be identified, particularly for critical HMI tasks.

6. Usability validation (Optional)

Implement the programme of usability validation as defined in activity 4.

3.4 SUMMARY OF RESPONSIBILITIES

Table 2 summarizes each of the HMI development activities for both Category 1 and 2 projects. Discipline responsibilities identified in Table 2 are recommended, but are not intended to act as Shell standard. Allocation of responsibilities to disciplines may vary between individuals projects.

Table 2 Responsibility matrix

Activity	Project Manager	HFE Coordinator ¹	HFE specialist	C&I Engineer	Operations/ Maintenance	Procurement	DCS Vendor
HMI Category 1 projects (i.e. new HMI system development)							
1. Include this DEP in project baseline	APP	EXE		CON			
2. Define HMI baseline & concept		CON	EXE	CON	CON		
3. Specify HMI design requirements	APP	CON	EXE	CON	CON		
4. Define critical operator tasks		CON	APP	CON	EXE		
5. Include HMI requirements in C&I specification	APP	CON	CON	EXE			
6. Agree HMI style and validation plan		CON	APP	CON	CON		EXE
7. Review display designs		CON	CON		APP		EXE
8. Usability validation			APP		CON		EXE
HMI Category 2 projects (i.e. significant change to existing HMI, or change to existing HMIs supporting critical activities)							
1. Include this DEP in project baseline	APP	EXE		CON			
2. Identify and assess displays or activities affected		CON		EXE	CON		
3. Specify HMI design requirements		CON	APP	EXE	CON		
4. Specify HMI validation requirements	APP	CON	CON	EXE	CON		
5. Review changes		CON	CON	CON	APP		EXE
6. Usability validation		CON	APP		CON		EXE

Key:

EXE = Execute

CON = Consult

CHK = Check and verify results

APP = Approve

NOTE: 1. The HFE Co-ordinator is the individual from within the project team appointed to lead and organise HFE effort on the project. Details of responsibilities and competence requirements are contained in DEP 30.00.60.10-Gen.

4. HMI DESIGN REQUIREMENTS

This section defines seven fundamental HMI design requirements (DR) necessary to ensure high levels of usability and situation awareness in process control HMI systems.

The seven fundamental HMI design requirements are:

- DR1. Ensure cognitive compatibility with legacy systems
- DR2. Support operator goals and tasks
- DR3. Use visual coding to support direction of visual attention
- DR4. Let operators concentrate on performing operational tasks
- DR5. Support operator mental models
- DR6. Support simultaneous awareness at different levels of detail
- DR7. Support shared awareness

For each of these general design requirements, two levels of more detailed requirements are specified that, if achieved, will help to ensure the fundamental requirements are met:

- General Requirements: These are general design objectives that the HMI designer is expected to satisfy in order to meet the DR. There will be many different functional solutions to meet these general requirements.
- Functional Requirements: These are requirements for specific aspects of HMI functionality that can help to ensure the overall DR is satisfied.

Note that these requirements are not comprehensive. They will not, in themselves guarantee the required situation awareness is achieved. This is largely because SA is determined by many factors, of which interaction with the DCS system via the HMI is only one part. However, compliance with these requirements will go a long way to ensuring the HMI does not become a barrier to achieving and maintaining effective SA.

4.1 DR1: ENSURE COGNITIVE COMPATIBILITY WITH LEGACY SYSTEMS

4.1.1 Purpose

HMI development projects very often involve upgrading, modifying or adding functionality to parts of an existing DCS system, or introducing an entirely new workstation into an existing control room.

These situations can create particular usability issues – and in particular introduce the risk of human error – if:

- A single operator is expected to work with both the existing (legacy) system and the newly developed HMI to perform routine operational tasks.
- There are infrequent situations or modes of operation (such as startup, ESD, or abnormal conditions) where one operator may be expected to either revert to the legacy system, or make use of the new system, for relatively short periods of time.
- Operators working with the new system are required to exchange process information, or communicate in any way about the state of the system or current activities, using information derived from either system.

In these situations, it is particularly important that there are no important differences in the way information is represented, or the skills or knowledge needed to be able to operate the new system, that could lead to misunderstandings or errors when working between the two systems.

4.1.2 General Requirements for DR1

There are three general requirements that support DR1;

- DR1.1. Newly developed HMIs shall take full advantage of the functionality, performance and other capabilities offered by the technology to improve ease of learning, usability and human reliability. However, this shall not be at the cost of introducing risk of human error due to cognitive incompatibility between the new and legacy systems.
- DR1.2. As part of their HMI development plan, projects shall identify any tasks where either i) the intended immediate user(s) of the new HMI, or ii) other stakeholders, are expected to extract, communicate, change or otherwise use data or information represented on both the new and the legacy systems. These tasks shall be used as the basis for design review and usability validation to ensure cognitive compatibility between the two systems.
- DR1.3. Developers shall document all units of measurement, parameters, abbreviations, terminology, labels and information coding techniques to be used on the new HMI. These shall be reviewed to identify any areas where the same data or information could be represented in a different way across the new and legacy systems.

4.1.3 Functional Requirements for DR1

The following three requirements apply for specific HMI functionality support of DR1.

- DR1.4. Where the new system is required to display equipment or process-related information that is already presented on the legacy system, the information presentation format shall be consistent across the two systems. This requirement applies to, but is not limited to: units of measurement, abbreviations, terminology, and labels.
- DR1.5. Where feasible within the project constraints, information coding techniques, including background and foreground colours and the information prioritisation scheme, should be consistent across the new and legacy systems. As a minimum, the new system shall not use coding techniques used for critical or high priority information in the legacy system in a way that has a different meaning in the new system.
- DR1.6. The system for managing, prioritising and displaying alarms on the new system shall not be confusable with the legacy system. Specifically;
- o Alarms that have a similar level of importance for awareness of action by the operator shall appear and behave in the same way.
 - o The structure of alarm messages shall be no less informative or harder for the operator to understand when compared with the legacy system. (New systems are expected to provide significant improvement in usability of alarm systems. New alarm systems shall not simply replicate legacy systems, though they shall not be less informative or easy to use, or introduce risk of alarm flooding or overload).

4.2 DR2: SUPPORT OPERATOR GOALS AND TASKS

4.2.1 Purpose

Facilities shall proactively manage their processes and be able to respond quickly and effectively to process deviations. The ability to do so requires that the human operators who are part of the system are supported in their situation awareness of the process, in their decision making, and in performing their tasks.

Supporting these operator needs requires that the design of HMI displays support the goals and tasks that define the role of the operator in the system. This means supporting the operator during all modes of operation, including normal operations, startups, shut-downs, and abnormal situations as well as upsets and emergencies. It includes communications,