

Human factors engineering in oil and gas - a review of industry guidance

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Abstract. Oil and Gas Exploration and Production activities are carried out in hazardous environments in many parts of the world. Recent events in the Gulf of Mexico highlight those risks and underline the importance of considering human factors during facility design. Ergonomic factors such as machinery design, facility and accommodation layout and the organization of work activities have been systematically considered over the past twenty years on a limited number of offshore facility design projects to a) minimize the occupational risks to personnel, b) support operations and maintenance tasks and c) improve personnel wellbeing. During this period, several regulators and industry bodies such as the American Bureau of Shipping (ABS), the American Society of Testing and Materials (ASTM), the UK's Health and Safety Executive (HSE), Oil and Gas Producers (OGP), and Norway's Petroleum Safety Authority (PSA) have developed specific HFE design standards and guidance documents for the application of Human Factors Engineering (HFE) to the design and operation of Oil and Gas projects. However, despite the existence of these guidance and recommended design practise documents, and documented proof of their value in enhancing crew safety and efficiency, HFE is still not well understood across the industry and application across projects is inconsistent. This paper summarizes the key Oil and Gas industry bodies' HFE guidance documents, identifies recurring themes and current trends in the use of these standards, provides examples of where and how these HFE standards have been used on past major offshore facility design projects, and suggests criteria for selecting the appropriate HFE strategy and tasks for future major oil and gas projects. It also provides a short history of the application of HFE to the offshore industry, beginning with the use of ASTM F 1166 to a major operator's Deepwater Gulf of Mexico facility in 1990 and the application of HFE to diverse world regions. This latter point highlights the need to consider user populations when selecting HFE design criteria, an aspect strongly emphasized in current industry guidance.

Keywords: oil and gas, facilities design, regulations, energy

1. Introduction

Brazil is the ninth largest energy consumer in the world and the third largest in the Western Hemisphere (after the United States and Canada), and has been a net exporter of oil and gas since 2009 [1]. Brazil's proven oil reserves are considerable, and may be comparable with those of the UK North Sea [2]. Petrobras, Brazil's largest energy company, re-

cently announced plans to expand their rig fleet and triple production to 6 million barrels a day by 2020 [3] – a rate that would equal the North Sea's peak production (achieved in 1999, [4]). Meeting these production targets will require accessing hydrocarbons from fields located at substantial depths; for example, the giant Tupi field which lies some 4.5 miles beneath the ocean's surface in the subsalt layer.

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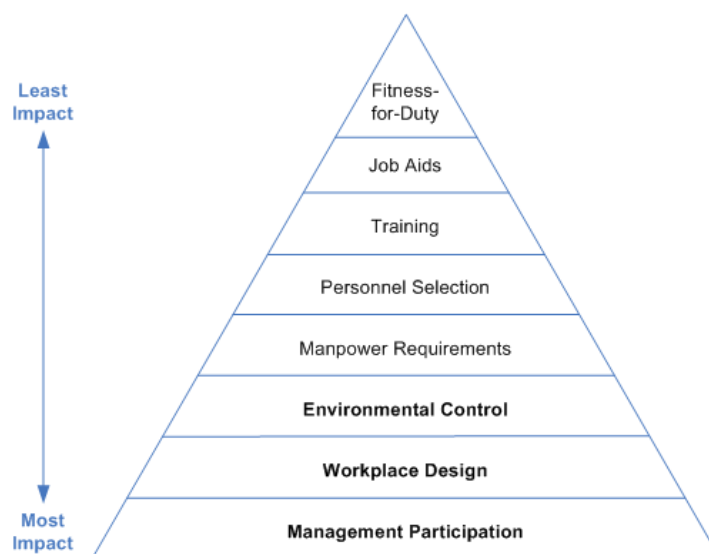


Figure 1

The Human and Organizational Factors "Triangle of Effectiveness" model for reduction of human errors. HFE addresses Workplace Design and Environmental Control, two areas with a high impact that are founded on Management Participation.

Finding and producing offshore oil and gas contains inherent risks that are especially distinct in deep waters. The explosions and subsequent sinking of Petrobras' P-36 with the death of 11 workers in March 2001 is a reminder of those risks, as is the April 2010 sinking of the Deepwater Horizon semi-submersible (which also claimed 11 workers' lives and led to total loss of the facility). Human Factors deficiencies such as poorly implemented alarm systems and human-system interfaces that did not support effective situational awareness permitted escalation of these events. A lack of risk awareness, issues with emergency response training, and insufficient safety culture (manifesting as a focus on financial performance and avoidance of necessary maintenance activities) were also clearly implicated in both incidents.

Human Factors Engineering (HFE) is a discipline that aims to systematically address human-system integration issues via practical activities applied during the design, fabrication, construction and decommissioning of oil and gas facilities. The aim is to reduce the opportunities for human error and minimize the effects of the errors that do occur by designing equipment and work systems in accordance with sound HFE principles. The effect of HFE activities should be an installation that supports situational awareness of those working in control rooms, build-

ings and other areas of the plant, facilitates maintenance activities and supports emergency responses.

HFE applies to the areas of workplace design and environmental control; two application areas with a high impact on safety and operator performance according to the Human and Organizational Factors' "Triangle of Effectiveness" model (), which is explained further in other papers (e.g. [5], [6]). As has been noted [7] HFE is a new discipline to oil and gas, and as such is only able to be applied effectively on the basis of adequate Management Participation and buy-in.

Systematic HFE programmes have been implemented within Major Capital Projects in the offshore sector over a period of at least twenty years. Much has been learned during this period and this experience is included within industry-specific guidance. Respected industry bodies provide this guidance, and several regulators also provide standards recommending or requiring HFE activities. Professional personnel are available to those companies who wish to apply HFE to the design of their facilities.

It is noted that application of HFE has historically been inconsistent on projects. One of the reasons given for this is that guidance on specific application has been lacking [8]; for example the American Petroleum Institute (API's) recently mandated Recommended Practice 75 [9] contains instructions that

Human Factors should be considered, but no specific guidance on how this should be achieved is given.

Industry-specific HFE guidance that may bridge this gap is becoming available; it is harmonious, practical and based on project experience. The remainder of this paper aims to summarize some of the available guidance, and introduce the reader to the main principles of application.

2. Industry Guidance

2.1. Regulators' guidance

National Regulators have a large part to play by providing a driver for HFE, encouraging compliance and following-up. Several regulators provide structured guidance relating to HFE and have expectations that facilities designed for use in their area of jurisdiction will provide documented evidence of a systematic approach to HFE.

2.1.1. HSE -UK

Since 1992 the UK has required that all fixed and mobile offshore installations operating in its waters shall have a safety case accepted by the Health and Safety Executive (HSE; [10]). The safety case regime focuses on prevention of major accidents, and the HSE recognizes that the greatest opportunity to eliminate or minimize hazards is during design. *The HSE also recognizes that decommissioning of facilities may require HFE input.* Assessment Principles for Offshore Safety Cases (APOSC, [11]) contains the provision that "the major accident risk evaluation should take account of human factors" (Principle 8) and "...the (safety) case should show how relevant good practice and judgement based on sound engineering, management and human factors principles have been taken into account" (Principle 13). Several sentences provide more specific guidelines, including:

..."consider people as both a key element in safe operation and as a potential cause of major accidents and their escalation" (Paragraph 43);

"Safety critical tasks should be analysed to demonstrate that task performance could be delivered to the specified performance when required..." (Paragraph 45); and

"The effects of hazards on human performance should be evaluated to ensure decision-making capability or the ability to evacuate or escape does not become impaired" (Paragraph 48).

The paragraphs above indicate the kinds of HFE studies and analysis expected and it is clear that Human Factors expectations are high within the UK regulator.

One of the key drivers towards this maturity was the 1988 Piper Alpha disaster and subsequent investigation that identified many Human Factors failings and led to the HSE taking responsibility for offshore safety.

Specific design guidance is provided by the HSE in the form of web-based resources and several downloads (e.g. *Human Factors and Ergonomics* [12]; *Human Factors: Design* [13]). Specific guidance on implementing Human Factors into oil and gas projects is not provided; however a 2002 research report discussed the application of military-based Human Factors Integration (HFI) to the oil and gas sector [14].

2.1.2. NOPSA -Australia

In common with the UK HSE, Australia's National Offshore Petroleum Safety Authority (NOPSA) runs a performance-based regime with an emphasis on safety cases. NOPSA commenced operations in 2005 and a recent presentation made by the CEO of NOPSA [15] indicates the organization's awareness and focus on Human Factors issues. NOPSA is currently aiming to develop specific human factors guidance in the near future [16].

2.1.3. Petroleum safety authority -Norway

The Norwegian authorities provide technical guidance on HFE that is generally prescriptive rather than goal-setting and requires systematic HF input for new facilities and modifications. NORSOK S-005 (Working Environment Analyses and Documentation, [17]) describes HFE roles and responsibilities, activities that should be carried out and how they should be documented. NORSOK S-002 (Working Environment, [18]) is a technical reference that contains design criteria, describes activities and prescribes methods. The NORSOK standards were intended to replace company specifications and function as references under the regulations; criteria they seem to meet well (some offshore companies publish their own additions to the requirements).

The prescriptive nature of the Norwegian system makes requirements and expectations generally clear, and the NORSOK system has many principles and design criteria in common with the other current good practice HFE documents. The Petroleum Safe-

ty Authority (PSA) is well resourced and follows up major projects via detailed audits.

2.1.4. ANP -Brazil

Brazil's Normative Regulations (NRs) for HSE relate to HFE; for example NR 12 (which includes provisions for machinery and equipment safety) NR 17 (workstation ergonomics, manual work and material handling arrangements) and NR 26 (Safety Signs).

The National Agency of Petroleum, Natural Gas and Biofuels (ANP) issued a resolution in 2007 requiring a full safety management system for projects ("Technical Regulation of Operational Safety Management System for Maritime Drilling Installations and Oil and Natural Gas Production"; Resolution ANP N° 43). This resulted in a goal-setting model with 17 management practices organized into three areas (Management, Leadership and Personnel; Facilities and Technology and Operational Practices). The first area includes reference to Work Environment and Human Factors [19], and includes the provision that "codes & standards for Work Environment and Human Factors should be identified and considered in design, construction, installation and decommissioning, establishing a potentially broad scope for HFE on projects.

An extensive HFE programme was carried out during FEED, Detailed Design and Construction of the *Frade* FPSO by one of the authors' colleagues, and the Brazilian-made *P-56* semi-submersible reportedly has a swimming pool and large outdoor football field [20], indicating considerable investment in worker wellbeing.

2.1.5. Engineering organizations' guidance

Early HFE guidance relevant to major projects was provided to the offshore industry by engineering organizations such as the International Maritime Organization (IMO), the Institute of Mechanical Engineers (IMechE) and the Institute of Electrical and Electronics Engineers (IEEE). The latter group has been involved with the development of Human Factors and Ergonomics from its early days, having sponsored early HF symposia (e.g. Fatigue Symposium, 1953, and Human Factors in Equipment Design, 1954). IMechE continues to develop documents for HF applications covering several industries. The IEEE standards (e.g. [21] and [22]) are aimed at addressing Human Factors within nuclear power generation.

IMO has produced guidance notes relevant to the offshore / marine sector, such as IMO Circular 834

(Guidelines for Engine-Room Layout, Design and Arrangement, [23]). This short document identifies the engine room as the most hazardous area on a ship, and provides guidance covering familiarity, occupational health, ergonomics, minimization of risk through layout & design, and survivability. IMO Circular (982: Guidelines on Ergonomic Criteria for Bridge Equipment and Layout, [24]) contains general requirements for bridge layout and workstation design to include consideration of the activities required at each station and encompasses arrangement of controls & displays, alarms, information display types, colour coding, fonts and wording of procedures. These notes are a worthwhile reminder for the designer to consider HFE principles, but given their unspecific nature they cannot be used as standalone design requirements. It should be noted that HFE professionals are not the authors of such guidance notes and they may in fact contradict currently accepted HFE design standards [5].

ASTM International is a developer of voluntary consensus standards and has developed two key offshore-specific HFE guidance documents. ASTM-F-1337 (Standard Practice for Human Engineering Program Requirements for Ships and Marine Systems, Equipment, and Facilities [25]) was developed by the US Navy and principally reflects the US Government's HFE requirements for ship procurement contracts. The document's content addresses scaling and integrating a Human-System Integration (HSI) program (which is mandated for US Government acquisitions) and details the expected deliverables.

The document provides HSI objectives for each project phase and outlines factors necessary for effective HSI delivery. It also provides personnel qualification and experience requirements for those who will carry out HFE activities.

The activities recommended in ASTM-F-1337 are broad and comprehensive, covering seven HSI domains (Manpower, Personnel, Training, Human Factors Engineering, Environment, Safety and Occupational Health, Personnel Survivability and Habitability) and therefore go beyond HFE to encompass each of the other HOF disciplines. Although intended to be applicable to both ships and offshore structures, the ASTM document is focused on military procurement and uses specific navy terms and includes U.S. Navy specific requirements throughout the document. These are likely to be unfamiliar to readers from commercial shipping and offshore industries. The activities described in ASTM-F-1337 are also based on a cyclical / iterative design method that also may

not be fully transferable to the normally shorter time-scales of an upstream oil and gas project.

A second ASTM document (ASTM-F-1166, [26]), provides specific design criteria for maritime vessels and structures, focusing on Human-Machine Interfaces (HMI) such as those between operators and control panels, workstations, alarms and displays, machinery spaces and equipment items. Now in its third version, the original version of this document was prepared in 1988 and was influenced by the widely used and authoritative Military Standard 1472F [27], among other references.

The document opens with key HFE principles (e.g. consider system users during design, identify and attenuate possibilities for human error; ensure similar items are installed consistently; ensure spatially match relationships between controls, displays and the associated items, and consider the backgrounds and cultures of users). However, the bulk of the fifteen chapter document contains specific design recommendations detailing aspects such as choice, location and arrangement of controls and displays and their integration (including audible displays and alarms), workstation / workplace design with specific details on access means (ladders, stairs, ramps, doors and hatches etc.) and typical equipment items. There are also sections on living and working environments, labeling and instruction design, hazards, Human-Computer Interfaces, communications and material handling.

ASTM-F-1166 contains many figures and tables, is highly practical and provides clear design criteria based on research and practice. The current version was updated in 2007 to include design criteria modified for other world populations in recognition of the fact that many seafarers and offshore personnel are from countries other than where the facilities are designed and built [28]. A simple example is provided in **Fout! Verwijzingsbron niet gevonden.**, which indicates that the maximum permitted valve height should be lower for certain populations.

Because of its emphasis on providing design criteria suitable for a wide range of user populations ASTM-F-1166 is now being used internationally for the design of ships and offshore facilities.

The American Bureau of Shipping (ABS) is also active in publishing HFE guidance. As an example their "Guide For Crew Habitability on Offshore Installations" [29] provides useful criteria and testing methods for environmental aspects. "Guidance Notes for The Application of Ergonomics to Marine Systems" [30] is a substantial HFE design manual. An industry-specific HFE guidance document was re-

cently described within a paper outlining ABS' practical approach to HFE [31], and it is understood that "Guidance Notes on the Implementation of Human Factors Engineering into the Design of Offshore Installations" [32] has been written and shall soon be published. This document is expected to include recommendations on integrating HFE into project management systems consistent with the aims of the American Petroleum Institute (API)'s RP 75 [9], which incidentally is a key driver for ABS' HFE activities. ABS sets a high standard for the quality of their publications and this document would be welcomed, however it remains unpublished at the time of writing.

2.2. Major oil and gas companies' guidance

The design requirements described above have been applied to the design of some oil and gas facilities by the procuring organization simply stipulating that the ship or offshore structure be designed in accordance with one or more of the design standards. However, this may not be a practical approach in all cases since the documents are lengthy and much of the content may be irrelevant to some projects or equipment vendors (who may also lack the expertise to properly apply the standards).

Therefore, some offshore oil and gas companies have used the above-referenced HFE design standards to create their own in-house company-, or even project-specific HFE design requirements documents. By extracting the pertinent and relevant parts from the above discussed HFE design guides and standards the companies have created their own HFE design requirements. By making the required HFE documents smaller and more directed at a particular company's projects it makes it easier for all parties involved in the design process to understand exactly what is required from a HFE perspective on a project-by-project basis. For example, Chevron's Safety in Designs [33] is a company-specific design manual applicable to onshore and offshore projects that provides guidance on the main elements of plant design and layout such as stairs, ladders and platforms, machinery guarding, access and layout, material handling and environmental requirements.

Other major upstream oil and gas companies have also produced in-house technical standards and processes for integrating HFE into projects; for example Shell has a number of Design Engineering Practices and BP has produced guidance and Engi-

neering Technical Practices that cover HFE and re-

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issues.

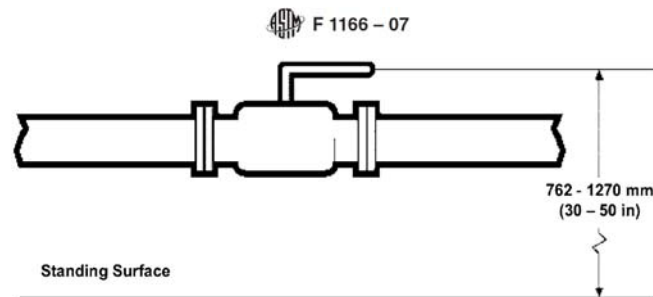


Figure 2

Image from ASTM-F-1166 indicating modification of valve height design criteria for world populations.

Figure's Caption reads, "These dimensions are appropriate for the 5th % female to the 95th % male maritime personnel worldwide except that the maximum height dimension should be reduced to 1143 mm (45 in.) to accommodate 5th % females from geographic locations such as West Africa, Southeast Asia, China, parts of Latin America, India, and Japan."

2.3. Industry associations' guidance

There is some commonality between these company standards and they share a practical approach to HFE. However maintenance of HFE guidance documents and technical standards requires considerable effort from specialist personnel, and not all companies have this capacity. Industry bodies therefore have a role to play in generating applicable practice, and the International Association of Oil and Gas Producers (OGP), a UK-based industry body that counts major oil companies as its members, recently released a document that outlines an "agreed" approach to HFE. The document is titled "Human Factors Engineering in Projects" and is available for free download from the OGP website [34].

The document scope deals with HFE issues within capital expenditure programmes, and is focused on HFE in design. The document places particular emphasis on ensuring HFE cost-effectiveness by planning the appropriate level of HFE competence and involvement according to the project's size and complexity. For large projects, HFE roles are identified both for engineering contractors and the sponsoring companies and formation of an HFE Working Group is recommended. Recommended activities are given over 5 main project stages:

- HFE Screening: reviewing the project for HFE risks, issues and opportunities.

- Design Analysis: verifying that specified technical standards cover HFE issues and risks, and analyzing design to ensure that safety-critical tasks are supported.

- Design Validation: following up on identified issues during detailed design project phase and verifying that HFE design quality is not compromised during construction.

- Support to start-up: ensuring HFE recommendations implemented and supporting start-up audit / commissioning inspections.

- Operational feedback: review the success of HFE and identify lessons learned.

This a structured approach that involves HFE at a suitable time in the project, includes guidance on preparing an HFE programme, continuity of HFE on the project and continuous improvement.

The guidance contains several useful appendixes which include clear visual examples of basic HFE issues, and incident reports that would be useful when preparing HFE training. An example HFE Screening tool is provided, as is a table of competence requirements for practitioners.

In summary, the OGP document reflects a relatively narrow HFE model when compared to some approaches (e.g. that of ASTM-F-1337, those based on the defence industry's Human Factors Integration and that of the UK's HSE). In this focused area the document provides practical guidance on resourcing, planning and carrying out an HFE programme on major capital projects. As an agreed approach for the industry it is a welcome addition to the HFE guidance in oil and gas.

3. HFE success factors

Several conditions for successfully integrating HFE onto projects are known; these factors are cru-

cial because a human factors professional does not “own” anything in the system, and is powerless to impact the design unless these conditions (especially management and engineering buy-in) are present [5]. Some of the key recommendations are summarized below:

- Establish management commitment to HFE and appoint an HFE Champion (management commitment is essential; the HFE Champion promotes HFE issues and provides a link between the HFE practitioner and the project management team).

- Apply HFE during all phases of a project.

- Provide an early focus on known HFE problem areas and lessons learned from other facilities.

- Locate HFE personnel within the engineering design team to foster discussions and trust. It is more effective to act as an integrated part of the design team rather than an external enforcer of standards).

- Mandate HFE in the project design and mandate accepted HFE design standards in project specifications.

- Incorporate HFE activities into the programme plan.

- Provide management oversight of HFE activities.

- Require close cooperation between HFE, Operations / Maintenance and other engineering disciplines throughout the project lifecycle (ASTM-F-1337 and

the OGP document recommend formation of a working group for large projects)

- Engage academically educated and experienced HFE professionals. HFE is a unique engineering discipline that applies specific knowledge of human capabilities and limitations and should not be assigned to other engineers from other disciplines, health professionals or former operators / maintenance staff.

As a relatively new discipline, it is important to effectively manage the integration of HFE on projects. Utilizing suitably qualified personnel to apply the appropriate tasks in a suitable organizational climate should maximize the success and impact of HFE on projects.

4. Common HFE activities for Major Projects

Table 1 summarizes the set of activities that are generally agreed-upon for a structured HFE programme for a Major Project. The reader is directed to the referenced guidance documents for further details on timing and competence required to plan and perform these activities.

Table 1
Summary of generally-agreed HFE Activities for Major Projects

Activity Name	Project Phase(s)	Description	Tools Used / Method
Conduct HFE Screening	Concept Selection (identifying basic trade-offs between options), and Selection (more detailed screening when final project concept is chosen)	A structured and documented discussion to establish the project's HFE requirements and strategy.	Screening tool (for an example, see Appendix 3 of OGP guidance document; [34]).
Write Project HFE Strategy	Selection and Early Design	A summary of Screening activity summarizing key HFE risks and opportunities, activities and applicable standards / references. Establish HFE resource needs.	None (document).
Document, Track and Close-Out HFE Issues	From Early Design to Operation	A method for ensuring visibility, timely follow-up and close-out of HFE issues. Should include a formal method description for deviating from HFE requirements.	Spreadsheet, document or database software Human Factors Engineering Working Group (for large projects).
Review Project Standards	Early Design	Evaluating standards to ensure they support the HFE strategy and planned activities. Ensuring no conflicts between applicable standards and local requirements.	None.
Conduct HFE Awareness training	Early and Detailed Design	Educating management personnel, discipline engineers, vendors and site inspectors on HFE requirements, standards and expectations.	Illustrations of HFE principles; see Appendixes 1 and 2 of the OGP guidance document [34] for physical design and process safety incident reports. Lessons learned from comparable facilities.

Activity Name	Project Phase(s)	Description	Tools Used / Method
Generate HFE Design Aids / HFE Specification	Early and Detailed Design	Document establishing HFE goals and design criteria for the project.	Review of regulatory / company / industry bodies' HFE guidance.
Develop Task Analysis	Early and Detailed Design	A list of activities associated with facility, area or specific equipment items, broken down to understand the constituent tasks.	Specific software is available; may also be performed using spreadsheet / word processing software.
Safety-Critical task inventory	Early and Detailed Design	Detailed breakdown of tasks that could lead to serious consequences if performed incorrectly or omitted.	As per Task Analysis.
Valve Criticality Analysis	Early and Detailed Design	Classifying valves according to their criticality within the process and frequency of use.	Project HFE criteria.
Control Room Design Assessment	Early and Detailed Design	Evaluating design and layout of workstations and the control room / suite.	Various methods including Link Analysis, General arrangement drawing and 3D model reviews.
Facility Layout Reviews	Early and Detailed Design, and Construction	Evaluate layout for operability and maintainability.	General arrangement drawings, 3D model, Task Analysis, HFE Design Aids checklist.
Vendor Package Screening	Detailed Design and Construction	Assessing equipment (e.g. a pump package) design against HFE standards.	General arrangement drawings, 3D model, Task Analysis, HFE Design Aids checklist. Vendor site visits during construction.
Review procedures, manuals and labelling requirements	Detailed Design and Construction	Verify design and position of labels, signs and markings.	Physical inspection using HFE Design Aids checklist.
HCI Review	Early and Detailed Design	Evaluation of Human-Computer Interfaces	Various methods.
Review Alarm System	Detailed Design	Review each alarm signal to ensure it signifies a meaningful operator action and the system avoids alarm overload, alarm "chattering" etc.	Alarm Objectives Analysis / Alarm Rationalization
Review Accommodation Design	Early and Detailed Design	Verify suitable space provision, layout, emergency egress etc. within accommodation areas.	Various, including HFE Design Aids checklist.
Assist Material Handling	Early and Detailed Design	Ensure suitable provision of lifting aids to assist / reduce manual handling.	General arrangement drawings, 3D model, Task Analysis, HFE Design Aids checklist.
Evaluate Noise and Vibration	Early and Detailed Design	Identify high-noise items, evaluate means of reducing noise exposure (activity is usually performed by a Noise & Vibration specialist).	Various specialist software packages.
Evaluate Crane Operations	Early and Detailed Design	Identify layout for lifting needs and evaluate crane control cabin design, layout and interface.	General arrangement drawings, 3D model, Task Analysis, HFE Design Aids checklist. Crisis and Operability (CRIOP) Study [35].
HFE in Construction	Construction	Guide the construction contractor with respect to installing equipment not normally shown in 3D CAD models (e.g. small-bore piping and tubing, cable trays etc.)	HF awareness training On-site inspections.
Conduct follow-up evaluation	Operation (1-year post-startup is suggested)	Review: The level of operability and maintainability achieved HFE issues identified during operations Incidents and near-misses Lessons to be fed back Identification of HFE value.	Structured meeting with operations personnel.

5. Conclusions

There is now specific HFE guidance written for the oil and gas industry; the available documents are fairly consistent, describe an agreed approach and set out to explain how to plan and carry out HFE activities for major offshore projects. They also provide specific HFE based design criteria which is mandatory for a successful HFE program. This situation has evolved over a period of over 20 years during which established guidance from other industries has been tailored to the needs of the oil and gas industry.

20+ years of experience has clearly shown the value of adding HFE to the design of ships and offshore

structures. Further, it has been repeatedly demonstrated that this can be done in a cost effective way.

A partial list of projects that have applied HFE is shown in Table 2. This gives an indication of the range of world regions and scales of projects to which HFE has been applied.

The application of HFE remains inconsistent and some barriers to implementation still exist. However there is evidence of increasing regulatory interest in the importance of HFE, driven by incidents and increasing recognition of the need to support human performance. Now with guidance established for the oil and gas industry the HFE discipline may make further progress towards consistent application on oil and gas projects.

Table 2
Partial list of oil and gas projects that have applied HFE

Facility Name	Description	Year(s)	Location	HFE Activities
Auger	Tension Leg Platform (TLP)	1990 2001	Gulf of Mexico	HFE Programme during design and construction; Review and upgrade of new control room.
Boxer	Shallow Water Fixed Platform	1990	Gulf of Mexico	HFE audit of small existing platform.
Harvest	Shallow Water Fixed Drilling Rig	1991	Gulf of Santa Barbara	HFE review of Ship Traffic Control System.
Main Pass 289-C	Shallow Water Fixed Platform	1991	Gulf of Mexico	HFE evaluation of aux Control Room and Building Design.
Main Pass 252-A	Shallow Water Fixed Platform	1991	Gulf of Mexico	HFE evaluation of Production Module and Building Design.
Monarch	Jack-up Drilling Rig	1991	South China Sea	HFE audit of total rig design for new built rig
Mars and Mars B	TLP	1993 and 2009	Gulf of Mexico	HFE Programme during design and construction.
Amy Chouest	Offshore Supply Vessel	1993	Gulf of Mexico	HFE evaluation of Bridge.
Mars Turbine	Offshore Gas Turbine Enclosure	1993	San Diego, CA	HFE review of turbine design and total turbine package layout in its enclosure
Schat Watercraft & Survival Systems	Offshore Lifeboats	1994	Valley Center, CA. & New Iberia, LA	HFE evaluation for ease of operation and maintenance
Main Pass 143	Shallow water Fixed oil and gas transfer platform	1994	Gulf of Mexico	HFE design inputs to conversion of an existing platform
Ram-Powell	TLP	1996	Gulf of Mexico	HFE Programme during design and construction.
Sable Offshore	Three Offshore Gas Platforms	1996	Off coast of Nova Scotia, Canada	Total HFE effort for platform designs
Ursa	TLP	1998 2001	Gulf of Mexico	Initiated HFE for Ursa Project; Review and upgrade of new control room.
Ocean Confidence	Deepwater Drilling Rig	1998	Worldwide	HFE for conversion of hotel platform to drilling rig
Terra-Nova	Floating Production, Storage and Offloading facility	1999	North Atlantic off Newfoundland, Canada	HFE design and layout of the Turret Disconnect Panel

Facility Name	Description	Year(s)	Location	HFE Activities
Discoverer Enterprise	Deepwater Drill Ship	2000	Gulf of Mexico	HFE team evaluated total drilling process and equipment
Agbami	FPSO	2000	Nigeria	Review of all design project documents for HFE requirements
Na-Kika	TLP	2001	Gulf of Mexico	HFE design input and concept layouts for the control room
Agbami	FPSO	2001 - 2007	Nigeria	HFE Program from FEED through Construction & HUC project phases
Benguela-Belize	Compliant Tower	2003	Angola	HFE design input to CCR design
Tahiti	Spar	2004	Gulf of Mexico	HFE Framing Workshop
Boabab Field Development	FPSO	2004	Ivory Coast	HFE support in design of CCR via CAD concept layouts)
Frade	FPSO	2006	Campos Basin, Brazil	Total HFE support including control room layout
Valhall	Shallow Water Fixed Platform	2007	North Sea (Norwegian Sector)	Structured Working Environment programme during design and construction
Goliath	FPSO	2010	North Sea (Norwegian Sector)	Structured Working Environment Programme
Cheviot	Semi-Submersible	2011	North Sea (UK Sector)	HFE support to Topsides design

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