



GUIDANCE NOTES ON

THE IMPLEMENTATION OF HUMAN FACTORS ENGINEERING INTO THE DESIGN OF OFFSHORE INSTALLATIONS

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Foreword

Offshore companies, along with many other maritime entities, are becoming increasingly aware of, and are responding to, the critical role of the human element as the root of effective safety standards and practices. As a result, during the last two decades, the offshore industry began to concentrate more on improving human performance and reducing human error as a way to enhance offshore safety. The effort to improve safety and human performance introduced the engineering discipline of Human Factors Engineering (HFE) to the offshore industry.

Despite the positive experiences and results from including HFE design practices and principles into offshore design projects, HFE has yet to become a widely accepted and fully integrated aspect of design projects.

These *Guidance Notes on the Implementation of Human Factors Engineering into the Design of Offshore Installations* provide a strategy for integrating and implementing HFE into the design process as a way to help improve human performance and personnel efficiency and reduce safety risks associated with working and living on offshore installations. This integration of HFE into a program and the human element into the design can also improve overall system performance.

To help promote the effective integration and implementation of HFE design principles throughout the various lifecycle phases of an offshore capital project, a well-defined approach is required. The objective of these Guidance Notes is to identify the relevant HFE activities that need to be executed effectively and efficiently by describing a plan to integrate HFE into existing project management systems.

These Guidance Notes can be used as a roadmap for a larger effort to promote the application and understanding of HFE principles and criteria in system design and operations to help improve personnel performance and safety while reducing the potential for human error. It should be noted that the guidance presented in this document is recommendatory. Compliance with these Guidance Notes is not required, although ABS strongly urges the principles to be adopted wherever feasible and tailored based on the size and scope of the project.

These Guidance Notes become effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of these Guidance Notes is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

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SECTION 1 Overview of Human Factors Engineering and Its Implementation

1 Introduction

Understanding human capabilities and limitations is a primary means to overcome opportunities for human error. A significant amount of research has been conducted to identify the factors that shape and influence human behavior and performance in a work environment. These factors include such diverse issues as:

- How the workplace is designed
- Human-system interfaces (e.g., ease of use and accessibility)
- How employees are selected for particular jobs (e.g., knowledge, skill, and ability requirements)
- How job aids such as operational or maintenance manuals or procedures are written and/or illustrated
- Human-computer interaction
- Physical, visual, and auditory access for maintenance and operation
- How company policies and practices are presented to, and enforced on, the work force
- Training personnel and a myriad of other human behavioral and psychosocial issues that affect personnel performance.

The application of the results of this research to the design of tools, equipment, tasks, workplaces, procedures, hardware, software, the working environment, and even to company/organizational design, is known as Human Factors Engineering (HFE). Those who practice in this discipline are called Human Factors Engineers, Human Factors Professionals, or Ergonomists.

HFE is a unique and specialized engineering discipline that combines specific academic education and experience of the human's behavioral (i.e., social, physiological, psychological) and physical (i.e., size, strength, endurance) capabilities and limitations with that of the traditional engineering requirements to produce a human-system interaction that maximizes the best of both. This discipline allows for the human and system to work safely and efficiently.

HFE has broad areas of specialization and applicability. Therefore, for the purpose of these Guidance Notes, the focus of HFE is a domain of specialization largely concerned with human anatomical, anthropometric, physiological, behavioral, and biomechanical capabilities and limitations as they relate to human activity and the human-technology environment.

There are several formal definitions of HFE, including the following by the International Ergonomics Association (2014):

“The scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance”

Ergonomics, which is often synonymous with HFE in Europe, tends to focus on the biomechanical, physiological, and anthropometric capabilities and limitations that humans possess as they relate to the design of systems.

The general approach of HFE in mitigating human error in the workplace as a means to reduce risk to human performance and safety is as follows (in order of preference):

1. Design the workplace so that human error cannot occur.
2. Design the workplace so that if an error does occur the consequences can be mitigated to an acceptable level.
3. Provide training to prevent the error.
4. Provide hazard identification labels to warn personnel of possible hazard.
5. Write a procedure or create a company policy to attempt to prevent the error from occurring.

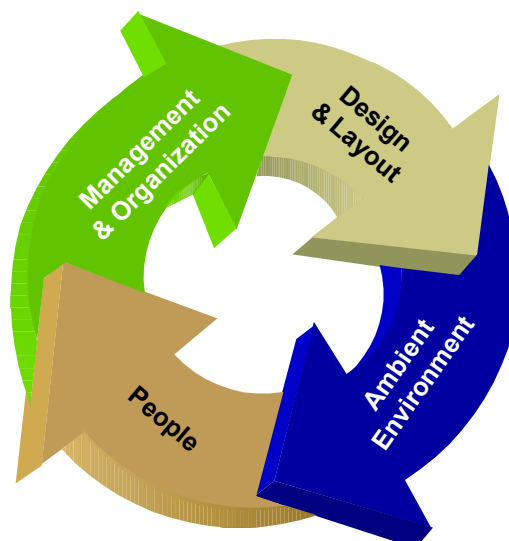
Proper design is the preferred approach, as it is the most preventative measure to take for workplace design. The driving force behind the inclusion of HFE in the design of any offshore installation is that efficient and safe operational performance starts with good design.

To conclude, integrating HFE design practices and principles that reflect human capabilities and limitations into a design project, as discussed in these Guidance Notes, will help result in installations that are more cost-effective, safer, and easier to operate and maintain. The earlier that HFE is integrated into a design cycle, the more cost-effective the HFE effort will become and the greater the potential impact on overall business performance.

1.1 The ABS Human Factors Engineering/Ergonomics Model: Elements that Enhance Human Performance and Safety

Section 1, Figure 1, “ABS Human Factors Engineering/Ergonomics Model”, below, encapsulates four (4) high-level “elements” that influence safety and efficiency in job performance: vessel or offshore installation design and layout considerations, workplace ambient environmental elements, management and organizational issues related to operations, and the personnel who operate the vessel or offshore installation. Insufficient attention to any of these elements may adversely affect safety, productivity, and efficiency. It is important that these elements be at the core of any HFE implementation effort. The structure and selection of activities described herein help promote this model and associated elements.

FIGURE 1
ABS Human Factors Engineering/Ergonomics Model



1.1.1 Management and Organizational Considerations

This aspect of the model covers management and organizational considerations that impact human performance and safety throughout a system's lifecycle. The implementation of an effective design and safety policy that includes human factors engineering and ergonomics will help create an environment that helps to minimize risks and reflects a good corporate safety culture for both system operations and to personnel. The commitment of top management is essential if this policy is to succeed. This commitment throughout the lifecycle means that it begins in early development with adequate resources to address HFE in design as well as the policy and personnel management required once the installation is operational.

In 1993, a study performed by the University of California at Berkeley found that 80% of all offshore accidents in U.S. waters were due to human error, and 80% of those occurred during operations. In 1995, the USCG launched a major initiative, called Prevention-Through-People (PTP), to reduce human error as a causative factor in maritime accidents when its research found that from 75-90% of all at-sea accidents were human-induced. This report also introduced the term "human element" to describe those factors which cause or contribute to human error. The preceding statistics illustrate the importance of the management considerations and commitment to implementing a comprehensive HFE program from inception through operations in order to achieve the human performance and safety goals.

1.1.2 Design and Layout Considerations

Design and layout considerations include those related to the interfaces between personnel (users, operators, maintainers) and equipment or systems. Examples of interfaces include: controls, displays, alarms, video-display units, computer workstations, labels, ladders, stairs, and overall workspace arrangement. For additional design and layout considerations, refer to the *ABS Guidance Notes on the Application of Ergonomics to Marine Systems*.

Designers and engineers should consider the ultimate user's cultural, psychological, and physiological capabilities, limitations, and needs that may impact work performance. In terms of cultural and regional influences on personnel's behavioral patterns and expectations, this includes understanding that there are different cultural meanings with regard to color, control movement compatibility, or that bulky clothing is needed when using equipment in cold weather. As a result, hardware and software design, arrangement, and orientation must match the associated characteristics and expectations of the users.

Awareness of potential physical differences (e.g., male/female, tall/short, Northern European versus Southeast Asian) is required so that the design, arrangement, and orientation of the work environment will reflect the full range of personnel given the characteristics of the users and the required tasks.

The likelihood of human error may be increased if these factors are not considered in the workplace design. Additional training, operations and maintenance manuals, and more detailed written procedures cannot adequately compensate for human errors induced by poor design.

1.1.3 Ambient Environment Considerations

The ambient environment addresses the habitability and occupational health characteristics related to human whole-body vibration, noise, indoor climate, and lighting. Substandard physical working and living conditions can undermine effective performance of duties, causing stress and fatigue. For example, working conditions that include high noise workplaces may lead to ineffective voice communications. Ambient environmental considerations also include the appropriate design of living spaces that assist in recovery from fatigue. For additional information on ambient environmental considerations, refer to the *ABS Guide for Crew Habitability on Offshore Installations* or the *ABS Guide for Crew Habitability on MODUs*.

1.1.4 Considerations Related to People

Personnel readiness and fitness-for-duty are essential for safety. These are especially important as tasks and equipment increase in complexity, requiring ever-greater vigilance, skills, and experience. The following factors should be considered when selecting personnel for a task:

- Knowledge, skills, and abilities that stem from an individual's basic knowledge, general or specialized training, and experience
- Bodily dimensions (anthropometrics) and characteristics of personnel such as stature, shoulder breadth, eye height, functional reach, overhead reach, weight, and strength
- Physical stamina; physiological capabilities and limitations, such as resistance to and freedom from fatigue, visual acuity, physical fitness, and endurance
- Psychological characteristics, such as individual tendencies for risk-taking behavior, risk tolerance, and resistance to psychological stress.

Choosing the correct personnel for the job or task is critical to overall safety and performance. Selection of personnel who do not have the requisite skills, training, or tools can adversely affect safety by reducing personnel efficiency and increasing the potential for error. While the focus of these Guidance Notes is affecting design to accommodate the capabilities and limitations of the intended users, the factors listed above need to be considered when defining the ultimate user population.

2 Application

These Guidance Notes present a strategy for the integration and implementation of HFE into the design of offshore installations and introduce general criteria that need to be considered throughout the various lifecycle phases. This strategy can be applied to fixed and floating installations, offshore terminals, or any other facility created for exploration, production, distribution, and/or transportation of natural gas and oil anywhere in the world. It is also applicable to any level of project design from new installation design and construction to existing facility expansion, modernization or upgrading.

3 Scope

The intended users of these Guidance Notes are HFE professionals with adequate education, training, and experience in the HFE profession, with particular expertise in offshore installations.

These Guidance Notes can be used as a roadmap for a larger effort to promote the application and understanding of HFE principles and criteria in system design and operations to help improve personnel performance and safety while reducing the potential for human error.

These Guidance Notes are a companion document to the existing ABS suite of human factors engineering-related documents such as the *ABS Guidance Notes on the Application of Ergonomics to Marine Systems*, *The ABS Guide for Ergonomic Notations*, and the various *Guides for Crew Habitability*. All of these documents can be downloaded free-of-charge from the ABS website (www.eagle.org).

These Guidance Notes address issues and concerns of HFE integration strategies and focus on specific implementation strategies that have been shown to be successful. The following Sections in these Guidance Notes cover the following:

3.1 Section 2, "HFE Implementation Program Planning"

This Section discusses a strategy necessary to establish an HFE Implementation Program. This includes:

- Plan for conceptual, early, and continuous use of HFE throughout all phases of the project.
- Engage academically-educated and experienced HFE professionals as well as other individuals critical to the success of the program.
- Determine level of HFE involvement.
- Obtain management commitment to HFE and appoint an HFE Champion.
- Require close cooperation between HFE, Operations/Maintenance, and other engineering disciplines throughout the entire lifecycle.
- Mandate HFE in the project design.

- Require use of accepted HFE design standards in project specifications.
- Provide early focus on known HFE problem areas/lessons learned from other offshore facilities.

3.2 Section 3, “Human Factors Engineering Implementation Program”

This Section discusses the strategy to run an HFE Implementation Program by outlining the HFE tasks that are typically performed on offshore design projects in the respective phase of design or construction. These project phases include:

- Conceptual Design
- Preliminary Design
- Detail Design
- Construction/Fabrication//Installation/Commissioning
- Operation

3.3. Appendices

- Appendix 1 References
- Appendix 2 Acronyms and Abbreviations
- Appendix 3 Example HFEIP
- Appendix 4 Example List of Vendor Supplied Equipment Requiring HFE in Purchase Specifications
- Appendix 5 Example HFE Statement to be placed in Vendor Purchase Specifications Packages

SECTION 2 HFE Implementation Program Planning

1 General

This Section discusses the strategies and considerations necessary to plan, establish, and operate an HFE Implementation Program. This includes specific commitments that should be made in order to achieve program success, activities undertaken in planning stages, as well as the personnel who should be involved in the implementation process and their roles and responsibilities.

2 Factors Critical to Successful HFE Implementation

Critical factors for the integration of HFE during the design's lifecycle include:

- The use of HFE throughout all phases of the project
- Engaging qualified HFE professionals
- Determining the level of HFE involvement
- Management commitment to HFE and the appointment of an HFE Champion
- Close cooperation between HFE, Operations/Maintenance, and other engineering disciplines
- Mandating HFE in the project design
- Requiring use of accepted HFE design standards in project specifications
- Providing early focus on known HFE problem areas/lessons learned from other offshore facilities

3 Engage Critical Parties in the HFE Implementation Process

There are potentially six (6) groups who may be involved in applying HFE to the design of any offshore facility. These include:

- i) HFE practitioners
- ii) The "Company" who will operate the facility
- iii) The lessee
- iv) Design agents
- v) The construction yard(s)
- vi) Product vendors/manufacturers

All of these groups can influence the effectiveness of the implementation of HFE. These different groups along with their responsibilities are discussed below.

3.1 Human Factors Engineering Practitioners

Human factors engineering is an engineering discipline concerned with the interactions among humans and systems and requires academic training typically not found in more traditional engineering disciplines. The Subparagraphs below list basic qualifications that the HFE professional should possess.

3.1.1 Education

The Human Factors Practitioner should have an advanced degree in engineering or psychology with emphasis in human factors, human factors engineering, or ergonomics.

3.1.2 Work Experience

- Preferably at least five (5) years of HFE experience in the design of heavy industrial facilities (e.g., offshore, refineries, paper mills, cement plants, chemical plants, shipbuilding)
- Preferably two (2) years of supervisory experience in a development project
- Desired areas of HFE design expertise:
 - Access aids such as stairs, ladders, walkways, work platforms, ramps, manways
 - Control/display/alarm design and integration
 - Console and control panel design, arrangement, and orientation
 - Design for enhanced maintainability of a complete facility and individual equipment
 - Design for ease of manual material handling
 - Design and selection of material handling equipment and operations
 - Familiarity with, and experience in, use of HFE design standards
 - Knowledge of human social, psychological, and physiological needs, and capabilities and limitations as applied to the workplace
 - Knowledge of labeling design standards
 - Knowledge of maritime crew habitability requirements and standards

3.1.3 Licensing/Certifications:

Professional certifications/licensing are preferred based on the level of involvement of the HFE professional in the design of the facility, but are not required. Ideally, the HFE professional should either possess or have the requisite experience and qualifications to be eligible to obtain a professional certification from a certifying organization such as:

- Board of Certification in Professional Ergonomics (BCPE)
- Canadian College for the Certification of Professional Ergonomists (CCCPE)
- Japan Ergonomics Society Certified Professional Ergonomists (JES CPE)
- Centre for Registration of European Ergonomists (CREE)

3.2 The Company Who Will Operate

The Company initiates, pays for, owns the project, and will operate the facility as a part of the Company's total assets. For example, an exploration and production (E&P) company may build a new drilling and production platform for installation in the North Sea. In this case, the Company has the final say on if, and how much, HFE input will be incorporated during the facility's design, and who will be the principal HFE provider. The actual implementation of HFE can then be achieved in one of three (3) ways:

- i) The Company can utilize an in-house HFE expert or hire an HFE professional to complete all the HFE tasks found necessary by the Company, design agent, construction yard, and vendors from conceptual design to operational phases.
- ii) The Company can require the design agent to utilize the services of an HFE professional who works for the design agent only.
- iii) The Company can hire an HFE professional consultant to periodically evaluate the engineers' HFE efforts, usually near the end of the detail design phase.

All three approaches are ranked in order of effectiveness, with the first (an HFE professional to perform all tasks) being the most effective.

3.3 The Company Who Will Lease

A Company initiates, pays for, owns the project, and may even operate it, but does so under a lease arrangement to another Company (e.g., an independent E&P company). For example, a drilling company may design and build a new drilling rig based on a multi-year lease with an E&P company. In this case, both the drilling and E&P companies may have specific design requirements they wish to be incorporated into the new design, including HFE. Typically, the lessee (i.e., the E&P Company) will have more influence on the implementation of HFE.

3.4 The “Design Agent” Working for the Company

It is common that an outside marine engineering or naval architectural company (design agent) will be hired to assist with the facility design. In these instances, the Company has the responsibility to advocate HFE representation during design. The Company can take the lead to provide HFE professionals or they can oversee the HFE efforts performed by the design agent’s HFE professionals.

3.5 The “Design Agent” Working for the Construction Yard

In some instances, the design agent’s role has been filled by the “construction yard”. Most large construction yards possess their own design engineers who serve as the design agent for the detailed design. The yard’s engineers would then be responsible for the inclusion of HFE into the design. In these instances, the Company has the responsibility to recommend that there is HFE representation during design. The Company can take the lead to provide HFE professionals or they can oversee the HFE effort completed by the construction yard’s HFE professionals.

3.6 The Vendor/Manufacturer

The last group that plays an important role in the application of HFE is the vendors and manufacturers who make or supply equipment for the project. It is unusual for a vendor or manufacturer to employ HFE professionals, so the Company has the responsibility to recommend that HFE design requirements are included in the original vendor bid specification and that vendors and manufacturers comply with this bid specification.

4 Determine the Level of HFE Involvement

A reasonable question to ask is whether or not HFE should be involved in a project, and if so, to what level. It is understood that projects can range from simple (e.g., replacement of piping, or simply adding another piece of equipment, skid, or process train that already exists in the system to increase production rates), to intermediate (e.g., adding a new system to an existing one), to major (e.g., the design and construction of a new offshore drilling rig or production platform). As a result, HFE may not be needed for every design project or, if needed, may be limited in the HFE tasks required because the project does not warrant extensive HFE involvement. However, it is suggested that an HFE evaluation be completed for all proposed capital projects to assist the Project Manager in determining if, and/or to what level, HFE should be involved.

As a guide to help determine HFE involvement, the following survey has been developed (see Section 2, Table 1, “HFE Involvement Survey”). A “YES” answer to one or more of the questions indicates that there should be some HFE involvement. In addition to this survey, the required level of HFE involvement should be reviewed by a qualified HFE Practitioner.

4.1 Tradeoffs

In the practice of applying HFE principles in design, an ongoing process of considering tradeoffs will occur within and among the elements of the ABS Ergonomic Model described previously in Section 1, Figure 1.

Tradeoffs allow for compensation across these domains to provide an appropriate level of human performance and safety. Ergonomic design of human-system interfaces will influence job complexity, which in turn affects personnel knowledge, skill requirements, training requirements, etc. There are other significant factors contributing to the outcome of tradeoff decisions, including:

- i) Cost (e.g., engineering, construction, commissioning, operating, decommissioning)
- ii) Risk tolerance (e.g., business, human safety, environmental, technical, financial, societal reputation)
- iii) Statutory (e.g., laws and agreements that govern functionality and design)
- iv) Competitiveness

Human element and ergonomic concerns should have a competitive status with regard to other tradeoff elements.

TABLE 1
HFE Involvement Survey

No.	Question	YES	NO
1	Will the type of personnel involvement or the philosophies related to operation or maintenance of the new design or equipment differ substantially from the current practice of the company?		
2	Will the new design, equipment, instrumentation, etc., introduce new technologies or automation and impose new tasks and skill requirements on the operators/maintainers not previously required?		
3	Is there an opportunity to decrease operator/maintainer levels of error through improved design?		
4	Will the design be operated/maintained by individuals not normally assigned to work on the facility (e.g., outside personnel, contractors, vendor equipment repair specialists)?		
5	Is one of the objectives of the new project to reduce manning levels?		
6	Will the new design be used by personnel from a culture or geographic part of the world different than the individuals doing the actual designing and/or construction?		
7	Will the new design be operated or maintained by both men and women?		
8	Will the new design be provided with equipment or systems with which the operators/maintainers have had little or no previous experience?		
9	Is one of the goals of the new design to reduce accidents or incidences that have occurred on other facilities?		
10	Will the new design be significantly more complex than, or different from, any previously operated by the company?		
11	Is the new design a result of issues associated with HFE?		
12	Is one of the goals of the new project specifically to reduce operating/maintenance costs?		
13	Does the company have a specific corporate mission to enhance safety and quality of the work environment for its employees?		
14	Has the company had any previous unfavorable rulings from regulatory agencies on issues of employee safety, pollution control, or facility design based on HFE issues?		
Total # of "Yes" Answers _____			

5 Obtain Management Commitment

Management commitment to HFE is a crucial program element for successful integration of HFE into the overall design process for any offshore design project. Management commitment to HFE can be exhibited in several ways. These include:

- Creation of an HFE foundation and integration within the Company
- Creation of an organized management structure to promote the use of HFE
- Equalization of HFE with other engineering disciplines
- Requiring use of HFE principles in areas peripheral to direct engineering design, such as personnel selection, staffing levels, shift work, preparation of procedures, operation and maintenance manuals, and setting physical work environments
- Close cooperation between HFE and operations and maintenance personnel.

5.1 Creation of an HFE Foundation and Integration within the Company

An imperative first step is the creation of a corporate foundation for the successful integration of HFE throughout the phases of a capital design project. This is accomplished through the commitment of Company management for, and belief in, the value of HFE. This commitment should be exhibited as an obvious and normal part of doing everyday business and should also officially be established as a guiding principle within the Company's operating philosophy document or expressly stated in corporate policies, practices, or procedures such as in the Company's vision, mission, and/or objective statements. Examples of an HFE vision, mission statement, and objective statement that could be incorporated into a Company's operating philosophy or policy document are as follows:

5.1.1 Vision

To improve overall system performance and reliability in all company facilities and businesses by optimizing personnel performance, health, and safety through effectively integrating human factors engineering principles into the lifecycle of design projects.

5.1.2 Mission

To manage and integrate human factors engineering through all phases of the project lifecycle in order to minimize the potential for human error and optimize operability and maintainability during facility operation.

5.1.3 Objectives

Objectives for human factors engineering implementation include:

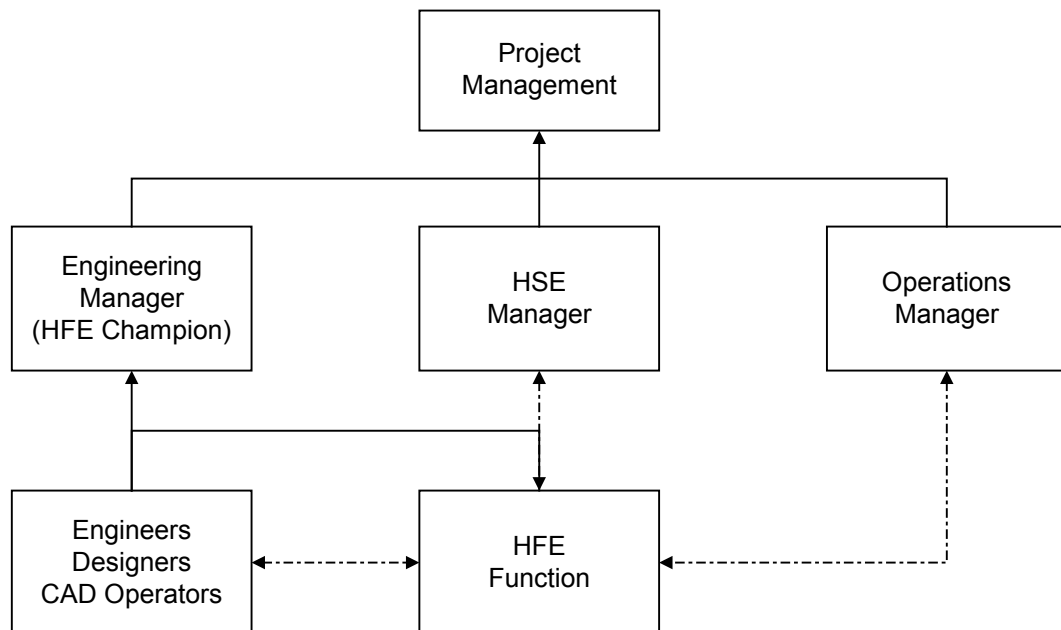
- Verifying management and line responsibility and resources for human factors engineering implementation within a project team
- Establishing accountability for implementation of human factors engineering within the project team.
- Verifying human factors engineering activities and tasks are effectively integrated into the project schedule for all major project phases.
- Creating awareness of human factors engineering at all levels of a project team including its design agents, construction contractors, and vendors.
- Commitment for demonstrating the economic and health, safety, and environmental (HSE) benefits from applying human factors engineering.

Establishing such philosophies as a corporate value, and requiring HFE appearance in each specific design project management document as a requirement (signed by the Project Manager, Chief Engineer, the HFE Champion and the HFE Professional) sets the stage for conveying to all personnel within an organization, including individual project teams, and contracted organizations or personnel, that HFE is a requirement that should not be omitted, minimized or subjected to subjugation to other engineering disciplines.

5.2 Creation of an Organized Company Management Structure to Promote the Use of HFE

The second way to demonstrate management commitment to HFE is to establish management and line responsibility for HFE within the Company as a whole and within each specific design project team. Project management should physically and organizationally locate the HFE activity such that it promotes interaction between HFE, Engineering, Operations, and Health, Safety and Environmental (HSE). Past experience has shown that a preferred location for HFE is with the Engineering function and with Operations as a good second choice. An example of an organizational location for HFE is shown in Section 2, Figure 1, "Organizational Location for HFE".

FIGURE 1
Organizational Location for HFE



As a part of this management organization, there should be a Company HFE Champion. This individual represents the HFE discipline and symbolizes the bridge between HFE and the other project team members. This individual should be located within the engineering department (for the Company) and the project design team (for individual projects). This person should have Company or project approval authority on all design, installation, and commissioning-related issues where there is a human component in the system, and it is suggested HFE be considered on an equal basis with the other engineering disciplines. In addition, the HFE Champion should have sufficient influence within the Company and project team to be able to direct engineering work and effect change.

The value of the “HFE Champion” has been amply and consistently demonstrated on past offshore capital design projects and should be actively involved in any Company and individual design project if HFE success is desired. This individual should be someone with an interest and understanding of HFE, and possess a human factors engineering background. The HFE Champion should not be responsible for performing the HFE tasks but should be the spokesperson for HFE within the rest of the Company or with the specific project. In addition, the HFE Champion should have final decision authority regarding all HFE issues if a conflict should arise between the HFE requirements and other design standards in the project design team.

5.3 Equalization of HFE with other Engineering Disciplines

The third action to demonstrate management commitment to HFE is to provide the same management oversight of, and attention to, HFE with the same enthusiasm and scrutiny as is provided to the other engineering disciplines. HFE requirements should be as important as any other engineering discipline and be given equal consideration in all design decisions. HFE should be expected to define its activities, successes, setbacks or shortcomings, and overall progress, and should be required to do so at all in-house or customer-based project design review meetings. It should not be required to justify its presence in a design project (economically or technically) any more or any less than any of the other engineering specialties.

5.4 Use of HFE Principles in Areas Other than Engineering Design

Company and project management should show their commitment to HFE through the utilization of knowledge and information in areas outside of HFE (e.g., in the conceptual design stage, be involved in the establishment of manning, safety, operations, and maintenance philosophies) and create a working environment that encourages inter-personal interaction among all levels of personnel and establish an organizational structure that provides communication and cooperation between all levels of the company.

5.5 Cooperation between HFE and Operations/Maintenance Personnel

The input from the expected users, usually represented by operations and maintenance personnel, is critical to the successful integration of HFE into the design of any offshore facility, and should be sought during every phase of the design cycle beginning with the conceptual design phase. By obtaining the opinions and knowledge of those who have a working experience with systems, equipment, and facilities similar to those under design, valuable lessons learned can be incorporated into the current design project. In addition, experience has clearly shown that when users are a part of the design team on a new project, their satisfaction with the finished facility increases.

The cooperation between operations and maintenance personnel and HFE professionals is critical to determining many of the design parameters and in the development of many project documents, such as operating and maintenance manuals and procedures. Operations and maintenance personnel provide specific details covering operation and maintenance task requirements that will be translated into the project design standards and guidelines, as well as being integrated into personnel competency profiles, staffing levels, HAZID (Hazard Identification) and HAZOP (Hazards and Operability) studies, materials handling, and valve criticality studies.

A close working relationship between HFE professionals and operators and maintainers requires that they be organizationally and physically located together (same design facility) to help facilitate a close affiliation.

6 Additional Critical Considerations

In addition to the foundation that management commitment and an appropriate organizational structure can provide, additional considerations for the implementation of the HFE program rest in the technical aspects that should be reflected in the design of the facility. These can be derived from industry standards, best practices, and from lessons learned from similar predecessor systems.

6.1 Mandate HFE in Design

Like any other technical specifications, HFE requirements should be included, imposed, and enforced.

6.2 Utilize Accepted HFE Standards

Accepted HFE standards for marine systems contain the appropriate considerations with measurable and verifiable criteria applicable to the design of offshore facilities. These standards, listed below, can either be referenced in their entirety in the contractual specifications or used as a basis for a project-specific HFE design standard tailored for criteria that only apply to the system to be designed:

- *Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities*, Standard F1166. American Society of Testing and Materials (ASTM). (2007)
- *Standard Human Engineering Program Requirements for Ships and Marine Systems, Equipment and Facilities*, Standard 1337. American Society of Testing and Materials (ASTM) (2010)
- *Guide for Ergonomic Notations*. American Bureau of Shipping
- *Guide for Crew Habitability on MODUs*. American Bureau of Shipping
- *Guide for Crew Habitability on Offshore Installations*. American Bureau of Shipping
- *Guidance Notes on the Application of Ergonomics to Marine Systems*. American Bureau of Shipping
- *Guidance Notes on Ergonomic Design of Navigation Bridges*. American Bureau of Shipping
- *Common requirements, architectural components & equipment (C-CR-002)*. Norwegian Oil Industry Association and the Federation of Norwegian Engineering Industries (NORSOK). (1996)
- *Working environment (S-002)*. Norwegian Oil Industry Association and the Federation of Norwegian Engineering Industries (NORSOK). (2004).

6.3 Lessons Learned

Any historical data related to human performance and safety issues can provide a wealth of information for follow-on designs and can help prevent past incidents and accidents from re-occurring.

SECTION 3 Human Factors Engineering Implementation Program

1 Introduction

Appropriate planning based on the information in Section 2, “HFE Implementation Program Planning” is critical in an effective HFE Implementation Program. An effective program includes numerous HFE tasks. These tasks comprise the program itself depending on the phase of development and the scale or scope of the project. HFE activities should be conducted as early as possible in the project’s lifecycle so as to have the most impact on the design rather than after the detailed design of equipment and workplaces has begun.

Successful application of HFE depends on a proper process of conducting the appropriate activities in the various stages of the project’s development lifecycle. This Section describes the phases of development for a project, the typical HFE tasks that are conducted, and the responsible parties for the tasks.

2 Lifecycle Phases

Traditionally, the design process for any new or modified offshore facility encompasses several phases of design, construction, commissioning, on-site installation, start-up, and operation. Precisely how the lifecycle is divided into phases and the designations given to stages varies from project to project, but the objectives and outputs of the phases should be similar.

The actual number of phases is determined by the complexity of the project, whether it is a new facility or a modification of an existing one, and the reasons that the work is being done. Further, the number, names, and composition of each phase, especially during design, vary. However, for these Guidance Notes, the phases are identified as:

- *Conceptual Design (CD)* – In this phase, the project recognizes the systems needed, determines one or more appropriate options that meet the need, and decides which option(s) to develop further. During this phase, project goals are established and facilities’ performance requirements are determined.
- *Preliminary Design (PD)* – The conceptual design is increased in detail, with systems and individual pieces of equipment shown to scale and in their proposed layout, location, and arrangement within the facility. The goal of the preliminary design phase is to establish a proposed configuration that meets the project’s performance requirements and that shows enough detail so the proposed arrangement and configuration can be adequately judged to progress to the next phase of the design process (i.e., detail design).
- *Detail Design (DD)* – The facilities to be implemented are defined both in functional and physical terms and have the detailed requirements for implementation/construction.
- *Construction, Fabrication, Installation, and Commissioning (CFIC)*
 - *Construction/Fabrication* – Implementing the design and delivery of the physical systems that are ready for on-site installation.
 - *Commissioning and On-site Installation* – Realizing the physical system and making it ready for operation.
- *Operation* – Using the facility for its intended purpose, and supporting it so that it continues to operate.

The lifecycle stage of decommissioning is not covered in these Guidance Notes because there is very limited HFE experience/activity in this area at the current time.