INTEGRATION OF HUMAN FACTORS ENGINEERING INTO DESIGN – AN APPLIED APPROACH

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SUMMARY

To help reduce the potential for human error, it is important to effectively integrate Human Factors Engineering (HFE) principles into the design so that systems encompass human capabilities and limitations, while increasing system availability/safety/performance, and personnel satisfaction. This paper discusses an applied approach for HFE integration and implementation into the design, whether it be a new vessel, a facility construction project, or the expansion, modernization, or upgrading of an existing vessel or facility. This successful strategy has evolved over many years in the marine industry. This strategy integrates HFE throughout the various life cycle phases of a project with the objective of efficiently executing relevant HFE activities throughout conceptual, preliminary, and detail design as well as during construction and operation. Success factors are discussed and illustrated with examples from current and past design experiences.

1. INTRODUCTION

The objective of Human Factors Engineering (HFE) is to minimize the potential for human error and accidents and encouraging the performance of assigned activities as efficiently and effectively as possible. Human error can be a direct cause or a significant contributing factor for accidents onboard vessels and offshore facilities. Human error can lead to financial losses, production downtime, human suffering, environmental damage, and equipment loss and/or damage. Key factors related to human error include human-machine interface design, workplace design, procedures and job performance aids, as well as stress and fatigue. Methods for reducing human error include the use of established design standards, testing and evaluation procedures, such as interviewing subject matter experts (operators and maintainers), examination of work samples, experimentation, measurement of human performance in on-going task sequences, the use of human-in-the-loop simulation (including the training, knowledge, and skills a person needs to properly run a system), and the investigation of incidents to understand the cause of human error.

The International Maritime Organization (IMO) and the U.S. Coast Guard have independently estimated that human error is the direct cause of at least 80% of ship accidents and incidents in one way or another, be it the initiating cause, a cofactor that exacerbates unsafe conditions, or in failing to mitigate the effects of errors (Baker and Seah, 2004).

Human induced error, according to Meister (1971), is those characteristics of people that influence the potential for errors. These are Meister’s “human-induced errors” and include such factors as fitness for duty (e.g., fatigue, disorientation, distraction, impaired attention, lack of motivation, forgetting, complacency, confusion, incorrect expectancy, excessive stress, boredom, inadequate skills and knowledge, etc.). Such factors can contribute to the occurrence of errors, and in some cases even cause errors.

Factors external to the individual can influence the potential for human error as well. Elements of the job or task, design of equipment, operating procedures, and training can all affect the potential for error. These include system-induced and design-induced errors. System-induced errors reflect deficiencies in the way a system was implemented. They include mistakes in designating the number and type of personnel, system operating policies, training (competency assurance), data resources, logistics, organizational responsibilities, and maintenance requirements, and support.

Factors related to the design-induced errors can be described as “design factors.” Design factors include aspects of the system hardware, software, procedures, environment and training which affect the likelihood of human error. Design factors encompass such aspects of the system as: human-machine interface design; information characteristics (availability, accessibility, readability, currency, accuracy and meaningfulness); workspace arrangement; procedures; environments; and training. Design-induced errors result from human incompatibilities with the design of equipment. The resulting equipment design characteristics create special difficulties for the operator which substantially increases the potential for error.

The integration of HFE helps in the development of designs that effectively match human capabilities and limitations. The goal of HFE is to provide systems and equipment that reduce the potential for human error, increase system availability, lower lifecycle costs, improve safety, and overall performance.
This paper discusses critical success factors for effective human factors engineering implementation including, but not limited to:

- Commitment and support from the Owner at all levels of the Project organization
- Early and continuous involvement of HFE throughout the Project.
- Effective HFE Planning and Monitoring.
- Location of HFE discipline to promote interaction with other design disciplines.
- Interaction between HFE Personnel, Operators, and Maintainers.

These success factors (and others) are discussed and illustrated with examples from current and past design experiences.

2. HFE RESPONSIBILITY

"Who is responsible for the implementation of Human Factors Engineering principles?"

Answer: Both Owners and Contractors.

To increase the level of success for HFE integration, it is important for the Owner, at project initiation, to participate in HFE activities. Once a Contractor is selected, it is crucial for the Owner to cooperatively participate, in essence, "team" with the Contractor, in the design’s HFE efforts.

Listed below are some key Owner responsibilities.

- The visible commitment to HFE from initial (earliest) design stages through to the operational stage.
- HFE involvement in the design’s conception, including the determination of the design’s basis or required operational capabilities, safety and manning philosophies, operating environments, etc.
- Inclusion of HFE criteria/requirements in the design basis or specification.
- The identification of the HFE Lead who has the appropriate qualifications and the responsibility for and approval authority for HFE Plan.
- Promotion of interaction between HFE and other design personnel with end-users. This helps to encourage the adoption by designers of operational and maintenance concerns and ideas. End-user participation in the design helps improve “ownership” of the design and may also lead to a reduction of engineering change proposals during design and construction.
- Providing operational feedback concerning the success and failures of existing, similar designs or systems (what worked and what did not).

Historic HFE challenges pose the ingredients for successful integration of HFE into various phases of a project’s lifecycle. Theses challenges include: Owner commitment, Mandate of HFE, Assimilation of HFE, and Effective HFE Planning.

Example:

If a piece of equipment or system did not function properly because of poor maintainability access, this issue can be corrected before it gets incorporated into a new design. This is analogous to using “lessons learned” from similar designs or systems. Transferring lessons learned from one program to another can help prevent inappropriate designs from being used again without correcting any deficiencies.

2.1 COMMITMENT TO HFE

The commitment to HFE within an organization is an imperative first step in the creation of a corporate foundation for the successful integration of HFE throughout the phases of a 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 be officially established as a guiding principal and be expressly stated in Corporate Policies, Practices, or Procedures.

2.1 (a) Mission

The mission of successful HFE implementation is the management and integration of HFE through all phases of the project lifecycle in order to minimize the potential for human error and optimize operability and maintainability during facility operation. The HFE Mission should be incorporated into the overall organizational mission of the Company to prevent conflicts and maximize functionality.

2.1 (b) Vision

The vision of successful HFE implementation is to improve overall system performance and reliability in company facilities and businesses, by optimizing personnel performance, health, and safety through the effective integration of HFE principles into the lifecycle of design projects. The HFE Vision should be incorporated into the overall organizational mission of the Company to prevent conflicts and maximize functionality.

2.1 (c) Objectives

Objectives for HFE implementation include:
• Providing management and line responsibility with adequate resources for HFE implementation within a project team
• Establishing accountability for implementation of HFE within the project team.
• Integrating HFE activities and tasks into the project schedule for major project phases.
• Creating awareness of HFE at all levels of a project team including its design agents, construction contractors, and vendors.
• Demonstrating the economic and health, safety, and environmental (HSE) benefits from applying HFE.

2.2 MANDATE OF HFE

A mandate of compliance with HFE principles should be made by owners in the project’s design specification. The HFE requirements document should contain language similar to the following example:

“The Contractor shall design the [insert project name] to be operated and maintained by the 5th percentile female to the 95th percentile male of the expected user population wearing appropriate clothing and/or personal protection equipment and while performing all expected tasks. All hardware and software (whether vendor supplied or provided as a Contractor designed and constructed package), shall comply with the HFE design requirements contained in [list required HFE design specs/ergonomic design guidelines] (e.g., ASTM F1166 – Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities or the ABS Guidance Notes for the Application of Ergonomics to Marine Systems). Where compliance with these requirements may create severe design or economic challenges these, challenges shall be brought to the attention of the Owner for resolution.”

2.3 ASSIMILATION OF HFE

The integration of HFE with managerial and other disciplines helps in the development of designs that effectively match human capabilities and limitations. It is important that management mandates the use of HFE as a design discipline as well as monitor the HFE program efforts. Management should provide the same oversight of, and attention to, HFE, and 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 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. HFE should not be required to justify it’s presence in a design project (economically or technically) any more or any less than any of the other engineering specialties

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). Below is an example of an organizational location for HFE that has proven to be very effective in past capital design projects.

Figure 1: Sample Organizational Structure for HFE

2.4 EFFECTIVE HFE PLANNING

To help accomplish the HFE Mission, Vision, and Objectives, the following are example tasks that can be included as part of the HFE Program:

- Review/Development of early project design documents
- Identify HFE tasks and prepare the HFE plan
- Select/write the HFE design aids
- Conduct training
- Establish an HFE tracking database
- Carry out a manning assessment
- Conduct drawing/design reviews
- Apply HFE to vendor supplied Equipment
- Prioritize HFE efforts for systems / equipment
- Incorporate a labeling program
- Prepare/review operations, maintenance, and training materials/manuals
- Participate in special design studies
- Visit the construction yard and vendor facilities
- Prepare progress reports

The number and type of tasks in an HFE program depends on the complexity of the design project. Task responsibility is outlined later in Section 3 Table 1.

2.4 (a) Review/Development of early project design documents

Description:

HFE personnel should be part of the project team during the conceptual phase of a project and participate in project meetings and discussions involving personnel safety, productivity, habitability, and work area design. It will normally be necessary to review existing specific
design policies, philosophy documents, project design basis documents, or design specifications to determine what HFE requirements have been included, either explicitly stated or implicitly implied. The purpose of this task is to identify any existing HFE design requirements to verify they are incorporated into the final design of the project. These documents should state the objectives for the project, how, and by whom, the project will be managed, and what technical components will be involved in the project (this is the point at which HFE should be mandated for the project). These documents should also identify the project’s management structure, including where HFE organizationally fits within the project’s overall structure, and identify who may be involved such as the Contractor, Construction Yard, and Vendors. At a minimum, HFE input should require the design process to accommodate the physiological, psychological, sociological, and cultural characteristics of the anticipated end-user population for the installation. The purpose of the policy is to convey to the project team that implementing HFE is a commitment and is to be considered a normal part of project business.

Examples:

- A specification requiring alarms for, for example, fire, gas, abandonment of the vessel or to raise a general alarm, should address HFE concerns such as sound characteristics (loudness, frequency, verbal content) or type of alarm (horn, whistle, bell, or buzzer)
- In a specification requiring generator controls to be installed on a console in the Main Control Room, HFE guidance should be provided on control type or coding, or integration with related displays or alarms
- Design documents are modified to reflect the proposed crew’s cultural differences such as:
  - Worshiping practices (e.g., inclusion and placement of a prayer room)
  - Different cultural/religious dietary restrictions (e.g., separate preparation and cooking areas for foods)
  - Religious practices - some personnel maintain facial hair (e.g., beards) which impact the selection of personal protective equipment (e.g., respirators, escape packs)

2.4 (b) Identify HFE tasks and prepare the HFE Plan

Description:
The HFE Plan identifies the HFE activities to be performed, and how and when these tasks should be completed to support the effective integration of HFE into product design, construction, and operation.

It defines in detail the proposed HFE program that should be completed during the project and is used as a metric to gauge the progress/success of the HFE effort. Once accepted by project management it serves as the roadmap for participants to follow in completing the HFE program. The HFE Plan should be included in the Project Specification Document and/or the Design Philosophy Document.

The HFE Plan should identify the tasks to be performed, the schedule, linked to the master project schedule, to which each task will be carried out and the personnel responsible for each task. Any special studies (e.g., a link analysis of a control room) should also be laid out in the Plan.

2.4 (c) Select/write the HFE design aids

Description:
HFE Design Aids are a collection of the most important HFE design requirements packaged to provide quick and easy access to design criteria for specific HFE design requirements (e.g., operability/maintainability envelopes or control/displays concerns) of interest to the project engineers, designers, and modelers.

The design aid(s) reduce the time and effort required to find a specific design criteria without having to search through the full HFE design specification. The aids can be used throughout each design phase, construction, testing and commissioning.

Example:
Design aids can take many forms but the most common used on previous design projects is a design checklist which summarizes, in an easy to use checklist format, the major design requirements taken from the design standards chosen to be used on a particular project. The design aids should be distributed to all individuals (Company, Design Agent, Vendors, and Construction Yard inspectors) responsible for contributing to the design and construction of a particular offshore facility.

2.4 (d) Conduct training

Description:
This task provides introductory orientation training regarding HFE for all management, engineering, and design personnel. The first training session should occur early in the conceptual design phase and should be repeated when new personnel are added to the project. This would most likely translate to the training being given 2 to 3 times during the detailed design and at least once to both the construction/installation and commissioning. Different training programs should be offered for management, engineering, CAD operators, construction personnel, and inspection. This training is instrumental to the successful implementation of HFE since all Project team members should be aware of the
requirements for implementing HFE if successful implementation is going to occur.

Examples:
HFE Awareness Training typically consists of the following:

- Background – Accident/incident data
- Human Error - causes and solutions
- HFE roles and responsibilities
- Elements, benefits, and costs of HFE
- Design program’s HFE Plan
- Review of project design standards
- Design exercises using project design standard

2.4 (e) HFE tracking database

Description:
An HFE Tracking Database allows each recommended HFE design input - whether provided via attendance at a meeting, review of a preliminary or detailed design drawing, review of a vendor design, participation in a CAD review or any of the HFE tasks required for a project - to be permanently tracked throughout all project phases.

This database allows each HFE design input to be tracked and records all HFE inputs, whether or not the input was accepted or rejected (including the rationale for rejection). The database should track entries until closure. Reports identifying the HFE issues that are still open should be generated periodically and any lesson learned should be incorporated.

From the database, status reports are generated on a routine basis and shared with the respective design team. These serve as action items or checklist lists for the affected design discipline.

Example
The following is an example of an entry into a HFE Tracking Database, identifying the problem area and a proposed solution.

![Figure 2: HFE Tracking Database](image)

2.4 (f) Manning assessment

Description:
Manning Assessments should be conducted to determine and/or verify knowledge, skills and abilities and proposed manning levels for final designs.

Manning assessments are typically performed for jobs which are manpower drivers such as flight operations, crane operations and drilling, new systems, previous systems identified as a HFE concern and when proposed design changes are brought forth.

Examples:
Using workload and task analyses of an operation control center’s functions, HFE Personnel might recommend that the center’s activities could be safely and efficiently performed by one (1) less crew member.

There are significant cost implications to increase the number of persons on board (POB) during later phases of the project since the living quarters, utilities, fresh water, sewerage, and food storage capacities, etc. are based on a specific POB.

2.4 (g) Conduct drawing/design reviews

Description:
It is normal procedure that the Company makes a list of the drawings they intend to produce on a project. Therefore, as a part of the conceptual or early preliminary design effort, the Company should select from the overall master list of drawings to be produced for a specific project, a list of all drawings that should receive HFE review. Engineering drawings and design documents (including 3-dimensional module drawings showing plan, section, elevation and details) should be reviewed to verify that the design and layouts comply with project HFE design requirements, providing sufficient ingress/egress throughout the design and sufficient clearance/access for the operation and maintenance of equipment.

A master list of drawings for HFE review, a HFE drawing review procedure, provisions for the review of subsequent revisions of the drawings, and a process for the review of engineering change proposals should be contained in the HFE Plan.

The end product of this task is a list of all the HFE deficiencies and changes desired by the HFE personnel for each reviewed drawing. On past projects these have often been marked directly onto the drawings, (that is acceptable) but each HFE deficiency should also be entered into the HFE Input Tracking Database as well. The HFE personnel should then meet with the engineers who produced the drawings, identify the HFE concerns and seek a solution acceptable to both the engineers and HFE personnel.
The drawing review process should contain a provision for a HFE review for all subsequent revisions to a drawing after the first HFE review.

Examples:
HFE drawing reviews can identify:
- Improper height and orientation of manually operated valves
- Limited access to equipment (e.g., valves)
- Improper spatial relationships between crew and equipment
- Equipment protruding into walkways
- Equipment and structure placed in or along equipment removal routes
- Inconsistent orientation/placement of equipment
- Stair, ladder, steps, and walkway designs not consistent with HFE requirements

2.4 (h) HFE and vendor supplied Equipment

Description:
HFE deficient designs on vendor supplied hardware can be, and have been, identified as contributing to accidents and incidents on offshore facilities (ABS Draft 2008). HFE design requirements should be incorporated into appropriate vendor supplied hardware and software packages. Items should be selected based on the presence of HFE design requirements included in the vendor specification (e.g. consoles/panels, access clearances, etc.). HFE assistance should be provided to vendors on HFE issues during bidding. HFE personnel should also be involved in the bid package review prior to award.

Examples:
HFE Personnel should participate in:
- The development of vendor specifications
- Vendor meetings to clarify HFE concerns and explain HFE expectations
- Vendor package design drawings reviews (e.g., compressors, turbines, metering skids, water injection skids, and main pedestal cranes) to verify compliance with HFE requirements
- Project Equipment Procurement List development

2.4 (i) Prioritize HFE efforts for systems/equipment

Description:
It is important that the HFE Personnel review the equipment/systems/subsystems lists to identify potential HFE activities and those parts of the design, which should receive detailed HFE attention, prioritizing the various equipment/systems/subsystems according to HFE concerns and importance.

Examples:
Allow HFE personnel to focus on:
- Known problem areas (e.g., turret disconnect panel for an FPSO)
- Safety critical areas as identified by HFE task analyses
- High maintenance pieces of equipment
- Emergency evacuation routes and procedures

2.4 (j) Labeling program

Description:
Different labeling and marking procedures may create the potential for confusion among personnel. A Labeling Program should cover such design issues as label colors, contrast, character sizes, content and format as well as create standards for the various types of labels, signs and job aids used throughout the facility.

From a safety and operability perspective, a well-labeled facility is one of the most significant HFE contributions that can be made. An Owner from a major Gulf of Mexico E&P Company recently rated “good labeling” as one of the most important HFE contributions to its series of new offshore installations.

Facility-wide labeling includes the following types of labels:
- Identification labels that identify individual equipment, compartments and spaces,
- Control and display labels that are provided to identify the control or display, or to show how to actuate or manipulate a control
- Pipe markers (which includes pipe content and direction of flow arrows) presented in a color code to help the operator/maintainer identify what is in the pipe
- Hazard identification and warning signs
- Instruction labels that provide either step-by-step instructions, or general information on how to perform a specific task (e.g. launch a lifeboat)
- Information labels that provide general information
- Graphic labels such as a piping diagram, equipment schematic or chart

Figure 3 (ABS, 2003) shows examples of hazard labels with headers and signal words. These examples provide guidance on the appropriate colors, symbols, and language that should be used for hazard labels. The signal word “DANGER” should be white letters on a red background. The attention symbol exclamation point should be red. The equilateral triangle surrounding the exclamation point should be black. The signal word “WARNING” should be black characters on an orange background. The attention symbol exclamation point should be orange. The equilateral triangle surrounding the exclamation point should be black. The signal word “CAUTION” should be black...
Detailed specifications for the design, construction, and installation of all of the above labels should be included in the HFE specifications and made known to designers, vendors, and construction personnel.

One positive feature for offshore facility labeling is that each of the above listed types of labels is a stand alone requirement allowing companies to pick and choose as to what level of facility labeling they desire.

Offshore facility labels come from two basic sources; those written and manufactured by the Company, Design Agent or Construction Yard and usually installed (under supervision of HFE personnel) by the Yard; and those written, manufactured and installed by the Vendors. Regardless of where the labels comes from it is important that they all look alike. Therefore design parties must be familiar with, and consistently use, the same label design specification.

The first label effort should start early in the detail design phase, as soon as the first Piping and Instrumentation Diagrams (P&IDs) are released. The P&IDs will be one principal source of where, and what type, labels will be produced. Preparation of the labels should be done under the supervision of the HFE personnel. Other sources of information for label creation are equipment manufacturer operations and maintenance manuals, inputs from Operations Personnel and HFE personnel based on their previous experience, and the label writers own design background.

Examples:
- HFE personnel worked closely with a builder to develop a design-wide labeling and safety signage program
- HFE personnel participated in construction site surveys to identify labeling noncompliance
- HFE personnel worked closely with vendors to identify safety signs required and appropriate locations for these signs
- Identified all labeling requirements for topsides, vessel, accommodations, sub-sea and the dry tree unit (DTU)
- Developed an approved glossary of terms and define acronym and abbreviation usage
- Prepare labeling specification to include the following:
  - A list of equipment requiring labels, signs, pipe markers, etc.
  - Platform coordinated system/criteria, pipe marking criteria, component identification criteria, and regulatory signage criteria

2.4 (k) Prepare/review operations, maintenance, and training materials/manuals

Description:
The proper layout and design of technical manuals require HFE input. For the manuals to benefit the operations and maintenance personnel, it is important for them to be designed in an easy-to-read and easy-to-follow manner. HFE personnel can provide this type of assistance. It is important that the training media reflect the actual working equipment, environment, and conditions. Requirements should be developed for content, layout, format, and use of text and visual aids that enhance the usability and readability of manuals.

Operation and maintenance manuals come from three basic sources; 1) Manufacturers of equipments purchased directly from the manufacturer (e.g. fans, galley equipment, sanitary facilities, motors and pumps,), 2) Vendors who produce equipment skids or packages that contain manufactured equipment together with their own design of piping and instrumentation, and 3) those prepared by the Company, Design Agent or Construction Yard based on their own designs.

Considerable research has been performed regarding how people read and process information from books, manuals, checklists, etc. This research data has been translated into definitive design requirements that, if followed in the content, layout, format, location and use of text and visual aids, can enhance the usability and readability of a manual such as would be provided for operators or maintainers on offshore facilities.

Therefore, the Company’s HFE personnel should provide HFE design guidelines for the preparation of manuals to those in the project design team who will write any operations or maintenance manual not already written by a manufacturer. HFE personnel should also review the created manuals to verify they comply with the HFE design requirements and have been prepared by qualified personnel OR prepared in accordance with a writer’s guide and procedures writing manual.

The writing task should start in the Detail Design Phase as soon as the first completed equipment, skids or packages are delivered to the Construction Yard.

The end product of this task will be the actual operating procedure or manual provided to the crew.
Integration of Human Factors Engineering into Design- An applied Approach

Examples:
Examples of past special case operations procedures and manuals written by HFE personnel include:

- HFE professionals participated in the design and layout of the main in-country training center and training simulator for operations personnel.
- HFE professionals reviewed and provided input for operations and maintenance manuals.
- HFE professionals evaluated the software and user interface of the training simulator program.

2.4 (I) Participate in special design studies

Description:
Special studies may be required for a facility, particularly if the project is complex, large and/or new to the Company. The HFE personnel should participate in design studies that address HFE concerns and design requirements relative to O&M, manning, training, safety, etc. The HFE personnel’s primary involvement should focus on issues relating to crewmember performance or safety.

HFE should participate in special studies such as:
- Safety Cases
- HAZIDs / HAZOPS
- Emergency Evacuation
- Materials handling
- Lifeboat selection/placement

HFE input can help identify the potential for human error or injury and serve as a resource on potential solutions.

These studies should be identified in the Conceptual Design Phase if possible. Some studies (e.g. Function Analysis, Gross Task Analysis) may be initiated, and even completed, in the Preliminary Design Phase but it is preferable that they be done as early as possible so the results can be integrated into the design process.

It is important to note that special studies can be time consuming and costly, so that any special study should be done only if it will contribute directly to the design effort. Further, the studies identified here may or may not, need to be performed. Certainly not every study will be required every time, or on every project.

Identifying these studies, determining when, or if, they should be performed, and by whom is the responsibility of the HFE personnel in consultation with the Owner.

Examples:
HFE participation in special studies may include:
- Cost analysis of various POB scenarios
- Comparison of anthropometric data of project end user population
- Operational training simulator study on requirements, location and scheduling
- Living quarters cultural review
- Material handling studies including material handling equipment design
- Control Room design including the display screen layout (graphical user interface)
- Alarms (visual and auditory) selection
- Type and location of lifeboats, portable fire extinguishers and firefighting equipment

2.4 (m) Visits to the construction yard and vendor facilities

Description:
In most cases, HFE compliance can be accomplished by fabricators and construction staff adhering to the project drawings. However, for some details that are not included on the drawings, such as the position of valve control handles, the HFE personnel should check that the valve installation meets HFE objectives. Other areas that should be checked in the yard include the installation of signs, labels, pipe markers, equipment access for maintenance, and equipment removal rates. The objective of this HFE activity is to verify that the HFE requirements considered during the Detailed Design and Construction Phases have been implemented as per the design intention.

A particularly important task during these visits is to verify that installation of “field run” or “field installed” piping, wiring, equipment, etc. does not negate HFE design inputs made during detail design.

The frequency and length of these visits is determined by the HFE personnel doing the visits but should increase as construction progresses. Past experience indicates that these visits usually last from one hour or less up to half-a-day (for the larger rig or platform construction sites). They may vary from just one or two visits total at a vendor’s site to as often as once or twice a week at the Construction Yard during the latter stages of the construction phase. The visits normally involve a simple “walkthrough” by the HFE personnel who visually inspect the fabrication or construction work completed to date to identify HFE problems created as a result of the fabrication or construction activity.

HFE personnel during construction site visits should use the opportunity to identify HFE design discrepancies focusing on emergency escape and egress routes, location of fire and gas detectors, location of fire fighting equipment, improving access to valves and optimizing material handling.

Any detected HFE issues should be entered into the tracking data base by the HFE personnel, and should be brought to the attention of the Company, Vendor or Construction Yard inspectors.
Examples:

HFE Personnel might walkthrough a construction/vendor sight and investigate the following with respect to the project:

- Adequate maintenance access
- Design of permanent means of access
- Identification and elimination of head, shoulder and knee knockers
- Identification of suitable locations for safety showers and eyewash stations

2.4 (n) Prepare progress reports

Description:

This task should be completed across all phases of the design project. The HFE progress report is prepared by the contractor and is submitted to the Project Manager and HFE personnel at agreed intervals (i.e. monthly or quarterly). The report should briefly describe the HFE activities completed thus far, the general status of the HFE program, deliverables made, number and location of visits made to the Construction Yard and/or Vendors, and up-coming planned activities. Since the interaction between the HFE personnel and the Program Manager should be on a regular and routine basis, it should not be necessary to prepare a detailed and lengthy report. Instead, the report should only summarize the HFE activities.

Examples:

When developing the reports the following items should be considered:

- Review/changes to the HFE tracking database
- Review of other HFE activities performed
- Identification of tasks completed
- Identification of non-compliance issues
- Identification of HFE input not incorporated
- Identification of the status of all HFE activities in Tracking Database
- Explanation of why database items are “OPEN”, or why they have been closed out

3. RESPONSIBILITY FOR AND SCHEDULE OF HFE TASKS

Table 1 summarizes the example tasks (a – n) to be conducted during the different phases of a project lifecycle. This list is not intended to be a comprehensive list. However, it does contain all the key tasks outlined in this paper. Each activity listed shows when (Concept, Preliminary, Detailed Design, or Construction, Fabrication, Installation, and Commissioning) as well as by whom in the design process the activity should be performed (Owner and Contractor).

Table 1: Example Schedule of Tasks

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Project Lifecycle Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review/Develop Documents</td>
<td>Concept Prelim Detailed CFIC</td>
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<tr>
<td>HFE Tasks/HFE Plan</td>
<td>O O O</td>
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<tr>
<td>HFE design aids</td>
<td>O &amp; C</td>
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<tr>
<td>Conduct training</td>
<td>O O C C</td>
</tr>
<tr>
<td>HFE tracking database</td>
<td>C C C C</td>
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<tr>
<td>Manning assessment</td>
<td>O</td>
</tr>
<tr>
<td>Drawing/design reviews</td>
<td>O &amp; C</td>
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<tr>
<td>Vendor supplied Equipment</td>
<td>O &amp; C O &amp; C</td>
</tr>
<tr>
<td>Prioritize HFE efforts</td>
<td>O &amp; C</td>
</tr>
<tr>
<td>Labeling program</td>
<td>O &amp; C O &amp; C</td>
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<tr>
<td>Prepare/review materials/manuals</td>
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<tr>
<td>Participate in special design studies</td>
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<tr>
<td>Visits to the facilities</td>
<td>O</td>
</tr>
<tr>
<td>Prepare progress reports</td>
<td>C C C C</td>
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</tbody>
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O – Owner  
C – Contractor  
CFIC – Construction, Fabrication, Installation, Commissioning

4. LESSONS LEARNED

For more than five decades the offshore oil and gas industry has strived to make the offshore environment a safe place to work. Notable efforts have been exerted, and successes achieved in reducing the number of accidents and incidences occurring.

Companies are becoming increasingly aware of, and are responding to, the important role of the human element within effective safety standards and practices. During the last two decades, industry has begun to concentrate more on reducing the opportunity for human error as a way to enhance safety.

Based on past experience, the following attributes have been found to be important factors:

- Commitment and support from the Owner at all levels of the project organization
- Early and continuous involvement of HFE throughout the Project
- Effective HFE Planning
- The provision of awareness training
- HFE activity monitoring, equal to other engineering disciplines
- Use of qualified HFE personnel
- Location of HFE activity to promote interaction with the other design disciplines
- Continuation of HFE activities after the design has been built

Currently ABS is working on a Guidance Document related to the topic in this paper. The Guidance note is in the final stages of publication and is anticipated to be available later this year.
5. REFERENCES


6. AUTHOR BIOGRAPHIES

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