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Effective Integration of Human Factors into HSE Management Systems

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WORKING GROUP 5

2ND INTERNATIONAL WORKSHOP ON HUMAN FACTORS IN OFFSHORE OPERATIONS (HFW 2002)

EFFECTIVE INTEGRATION OF HUMAN (AND ORGANIZATIONAL) FACTORS INTO HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT SYSTEMS

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ABSTRACT

It is common that offshore operating and drilling companies have policies, procedures, and practices that address Health, Safety, and Environmental (HSE) issues. It is less likely that such organizations will explicitly address (through written requirements) human factors (HF) concerns. Regardless, both HSE and HF are concerned with the same objectives: protecting people, property, and the natural environment from damage. The methods of each examine the job performed by the human, and compare work requirements to the design of hardware, software, and paper systems to allow safe and efficient performance. The perspectives of both disciplines are generally "user-centered" and act as the advocates for the human user to influence design so that hazards are limited and efficient and productive human performance is afforded. In the end, both are cost-effective in that efficiency is enhanced, and production losses due to injury or equipment damage are avoided. Despite the similarities, HF, including ergonomics, is rarely comprehensively addressed by HSE policies, practices, procedures, and personnel. A problem exists in that, while most offshore operators have integrated HSE programs, portions of which include occupational health and safety and process safety management systems, few companies are sure how to integrate HF concerns. In particular, such companies are not sure what the role of HF (including organization concerns) should be if managed within the overall HSE management system (HSE MS).

The objective of this paper is to explore means whereby appropriate HF concerns can be effectively integrated and managed offshore. The context of the paper is the *managed application* of HF principles and methods within offshore operations, rather than a presentation of the details of HF data and methods, or of the mechanical aspects of associated HF analysis tools and processes.

During the 1996 International Workshop on HF in Offshore Operations, the Management Systems Working Group generated a paper titled: "Application and Integration of Human and Organizational Factors into Management Policies, Procedures, and Practices to Reduce Human Error and Improve Safety and Productivity" (Moore, et al., 1996). That paper presented extensive background material on the management objectives and activities for both HF and safety management. This present paper builds on that foundation and expands the scope from HF within process safety to HF within overall HSE management programs. This will be accomplished by:

- Summarizing the offshore HSE management and HF approaches and recommended practices
- Presenting a notional life cycle process of HSE management systems appropriate for offshore application
- Identifying potential HF participation in the HSE management development process, thereby integrating HF issues and concerns with overall HSE MS objectives and processes.

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1.0 INTRODUCTION

As defined by the International Association of Oil and Gas Producers:

> HF is the interaction of individuals with each other, with facilities and equipment, and with management systems. This interaction is influenced by both the working environment and the culture of the people involved. What may be a good system of work in one part of a organization may not be found in a region where the culturally driven attitude to risk taking may be significantly different. (International Association of Oil and Gas Producers, 2002).

Many industries, their related professional societies, or national governments, have recognized the importance of an effective HSE management system and so have developed their own HSE MS guidance tools to match the unique needs of their applications. Recent well known and widely used industrial HSE MS guidelines include:

- The American Petroleum Institute's (API) generated RP 75, *Recommended Practice for Development of a Safety and Environmental Management Program for Outer Continental Shelf Operations and Facilities*.
- The American Institute of Chemical Engineers (AIChE) Center for Chemical Process Safety (CCPS) has generated *Guidelines for Auditing Process Safety Management Systems*.
- The Health and Safety Executive's Publication, HS(G)65, of the UK: *Successful Health and Safety Management*, has significantly altered thinking on occupational health and safety management in many organizations.
- British Standard 8800, *Guide to Occupational Health and Safety Management Systems*, has been developed to improve occupational health and safety management by integrating it other aspects business management.
- International Maritime Organization's International Code*, International Management for Safe Operation of Ships and for Pollution Prevention* (the "ISM Code") for the shipping industry.
- E&P Forum for *Guidelines Development and Application of Health, Safety, and Environmental Management Systems.* (Note: the E&P Forum is now known as the International Assocation of Oil and Gas Producers or OGP).
- OSHA 1910.119, *Process Safety Management of Highly Hazardous Chemicals*
- UK HSE's PFEER, *Prevention of Fire and Explosion and Emergency Response on Offshore Installations.*

- UK HSE's *Design Safety: Measurement of Performance and Organizational Capability*.
- The *Occupation Health and Safety Assessment Series* (OHSAS) 18001:1999 was developed to enable organizations to control health and safety risks.
- OHSAS 18002:2000 is *the Occupational Health and Safety Management Systems-Guidelines for the implementation of OHSAS 18001*.

All of the safety management guidelines mentioned above are set forth to assist organizations in creating their own HSE MS. Even those guidelines set as regulation, like OSHA 1910.119, and HSE's *Prevention of Fire and Explosion and Emergency Response* (PFEER), or those which are industry recommended practices, like API RP 75, have as their basis a need for organizations to create their own systems of safety management. Compliance to this guidance can only be proven through performance since none of these documents were created to be prescriptive in nature. Each relies on a company to set its own policies and objectives within the guidance framework. The organization is then expected to control its unique hazards and the possible effects of those hazards via its systems of work, auditing, policies, and practices.

The introduction of management philosophies has significantly changed the offshore industry view of controlling processes and improving quality, health, safety, environmental, and operational performance. Historically, the philosophy of *process* safety management (PSM) has been to aid in identifying, evaluating, and reducing operational risks -- with emphasis placed on the prevention and/or mitigation of uncontrolled flammable, explosive, and toxic releases. In this view, distinctions are made between *occupational health and safety (OHS) risks*, on one hand, and *process safety risk* on the other. Table 1, below, summarizes the safety distinctions between these approaches.

Table 1. Thrusts of Historic OHSMS and PSMS

OHSMS Thrusts	Process SMS Thrusts
Biomechanical analyses (lifting, etc)	Failure mode analysis (primarily hardware)
Ergonomic safety (repetitive stress injury)	Emergency planning
Behavior based safety (personnel)	Industrial process surveillance (system monitoring)
Mechanical safety (crushing wounds, etc.)	Fire, explosion, toxic release control
Electrical safety (electrocution)	Human error
Health hazards (toxins, poisons, etc)	Environment spill, effluent control and cleanup

There has been little interaction between these safety efforts, since OHS generally came under the purview of occupational health and safety departments, while PSMS was a responsibility of engineering departments. Further, environmental safety is often a separate organizational entity, responding to environmental protection initiatives. These organizational distinctions are unfortunate since the objectives and processes are highly similar. The overarching goal of an HSE MS should be to coordinate and integrate the activities of OHS, PSM, and environmental safety.

People within the offshore industry recognize this, as there is growing consensus of the need to identify, evaluate, and manage all forms of risks that lead to or contribute to the majority of offshore incidents. Indeed, many organizations have expanded the scope of the "safety" department to include all aspects of health, safety, and environment. This is often reflected in these now being called the HSE department (McCafferty and Baker, 2002).

Accidents, such as Piper Alpha, Flixborough, Three Mile Island, Bhopal, and Chernobyl have emphasized to all heavy industry that there are factors beyond engineering that can influence whether an accident occurs and the extent of damage from the accident. It has also been recognized that focusing only on engineering controls or technological improvements do not prove adequate nor result in the desired reduction in the probability of such events. As a result, the current view to hazard control is that hazards should be managed by the following approaches, in order of priority (modified from API RP 75):

- Elimination – eliminate the hazard or the task, if possible.
- Substitution – substitute a less hazardous material, energy source or task.
- Engineering Controls – use measures to restrict access to or contain the hazard.
- Administrative Controls – use measures to remind workers of the hazards.
- Personal Protective Equipment – use PPE to reduce the exposure to workers.

In all cases above, HF can and should be considered in the design and implementation of these controls.

1.1 Human Factors and Control of Human Error

It is often noted that most accidents offshore are the result of human failings linked to ineffective management systems, and that as a part of risk management, organizations must create comprehensive schemes for managing HSE that include emphasis on human and organizational factors. It has become understood that satisfactory performance can only be achieved by positive management approaches. Such approaches should be used to guide facility design, human interface design, safety reviews, operations, staffing levels, modifications, maintenance, inspections, and the training of personnel. Many organizations have been attempting this, but are still unsure how HF is or can be effectively integrated into their approaches. Miller (1999) has proposed a model for integrating human factors and ergonomics concerns in systems design. He visualizes control of human error as a pyramid with six (variously) layers (approaches) to insulating offshore operations from incidents related to the occurrence of human error (see Figure 1). Review of Miller's figure reveals that management commitment forms the foundation of human factors in design and human error control.

Figure 1. Pyramid Notion of Human Factors in Design

Understanding that management commitment serves as the foundation to integrating HF approaches with HSE is necessary in order to lower risks and the number of HF related incidents. Nothing makes this clearer than the sheer number of conferences, symposia, and workshops where the topics of OHS, process safety, safety management, and HF and ergonomics are discussed in terms of their: (1) commonalties of objectives, methods, and processes, and (2) combined potential to influence offshore safety and environmental protection. The 1996 International Workshop on HF in Offshore Operations addressed this quite thoroughly, as the Management Systems Working Group generated a white paper, and several support papers, that developed and produced a foundation for a cohesive HSE MS incorporating all these elements. Numerous similar symposia, workshops, and conferences have occurred since the 1996 conference, and more are in the planning stage.

The 1996 workshop presented the overall goals of an integrated HF and safety program, and discussed topics such as:

- Overall Management design
- Work processes
- Team development and organization
- Safety and environment protection policy
- Allocation of safety responsibility and authority
- Required resources and personnel
- Development of plans, procedures and documents requirements
- Discussion of shared analytic methods such as hazard analysis, risk analysis, root cause analysis, and human error analysis
- Control and management of change
- Personnel selection and training requirements
- Requirements and processes for continuous improvement.

Others have noted similar goals as being integral to achieving risk reduction through safety management. In their paper, "Incorporating HF into Formal Safety Assessment: The Offshore Safety Case," Bellamy and Geyer (1992) have defined safety management as the control of identifiable contributors to hazardous incidents and accidents. They state that the concept of control is central to safety management. The goal is to control hazardous processes and minimize the likelihood of loss of containment incidents and to establish mitigation systems to best control the consequences of such incidents where they occur. To accomplish this, it is necessary to assess and, where required, to alter the factors which shape those management processes that affect safety. According to Miller (1999), there are five basic approaches to control hazards. These are, in order of preference and effectiveness:

1. Generate designs that obviate risk
2. Provide physical guards or barriers to risks and hazards
3. Employ markings, placards, and labels to alert humans to the presence of a hazard
4. Train personnel to know, recognize, and avoid hazards or risky behavior.
5. Observe work behavior and provide feedback stressing problem identification and resolution.

1.2 HSE MS Models

Internationally, industry and government agencies have accepted a model by which HSE MS can be organized for effectiveness. The philosophy of HSE MS is that organizations need to apply the management principles of planning, organizing, implementing, and evaluating to all aspects of HSE. Such efforts should be based on principles that aid in identifying, evaluating, and reducing risks with the particular emphasis being placed on the prevention and/or mitigation of uncontrolled and toxic releases.

A graphical representation of this model is presented in Figure 2, Key Elements to Successful Health and Safety Management. This model is adapted from the UK HSE's publication "Successful Health and Safety Management." By using this model, an organization develops a policy for HSE, creates an organization to implement the policy, develops plans for controlling the company's activities, and sets out standards by which performance can be measured. The model also has monitoring and auditing functions to measure performance and ensure that the needs for improvements are fed back into the organization.

Further detail on how an organization might meet the proposed model is presented in the publication "Management at Risk" published by the UK Atomic Energy Authority (1991). It is stated in this publication that "Corporate management must continually develop and maintain a Safety, Health, and Environmental Program culture by demonstrating conviction and commitment through certain activities." These activities include:

- Setting out written policy describing:
  - objectives
  - standards
  - priorities
  - authorities
  - decision reference points
  - management and communication structures that allow policy to be implemented and performance to be monitored.
- Implementing policy by
  - propagating and communicating policy
  - defining accountability
  - raising awareness and involvement of individuals
  - providing adequate resources
- Monitoring the performance of policy by
  - listening
  - taking proactive follow-up measures
  - eliminating deficiencies
  - taking initiatives (external auditing, training, analysis, assessment)
  - reviewing policy
  - rewarding good performance
  - auditing.

A key aspect of HSE MS is the creation of metrics for measuring where HSE goals are being met, and whether those standards are meeting their intended goal of minimizing risk. The performance criteria are used to monitor, audit, and review the HSE standards. Throughout the application of HSE MS, it is important not only that monitoring, auditing, and reviews occur but also that modifications are made to the HSE MS when deficiencies are noted, or when information on new ways of making improvements become known. The HSE MS must remain a living system where continual improvement is established as an objective. HSE MS improvements go hand in hand with Total Quality Management efforts. An excellent reference for describing how to integrate quality with HSE Management is provided in "*Integrating Quality, Environmental, Health, and Safety Systems*" by McDonald, Mors, Phillips and Phillips (2001),

Just as the basic model of planning, organizing, implementing, and evaluating has been accepted by many organizations worldwide, it is agreed that successful application of the model depends on human activities, including:

Decision making	Performance monitoring
Communicating	Feedback

People within an organization will be responsible for making decisions about what framework is to be used for establishing an HSE MS for an organization, as well as determining how the framework can be explained to others and how success or failure will be monitored. Taking a deeper look at HF within HSE MS, another goal of management is to reduce the potential for human errors, as well as to reduce equipment or system failures. Accordingly, Bellamy and Geyer (1992) have suggested the HF objectives presented in Figure 2 should exist within HSE MS.

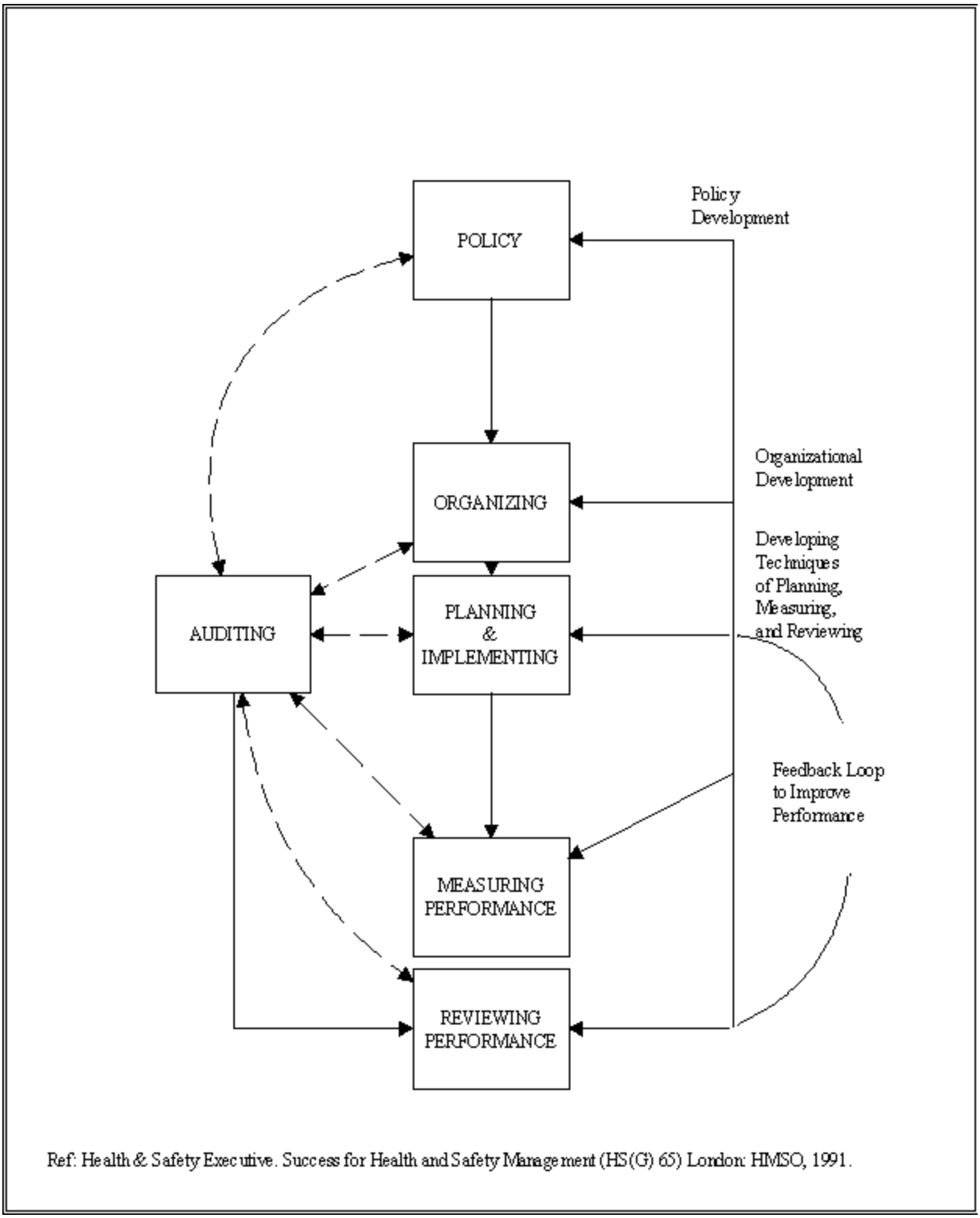

Figure 2. Key Elements to Successful Health and Safety Management

The objectives of this approach are:

- To provide personnel with
  - a design that they do not have to fight
  - procedures which are not bureaucratically cumbersome, difficult to perform, or hazardous
  - necessary and unambiguous information
  - a working environment conducive to minimizing stress and discomfort.
- To select and train personnel such that their knowledge and skills are appropriate to the tasks which they have to perform, and to maximize personnel performance capabilities.
- To motivate people to perform safely and minimize pressure to do otherwise.
- To monitor performance, identify deviations from safety standards and to eliminate conditions conducive to error or procedure violations.

The Cullen Report (1990), which followed the Piper Alpha accident, identifies topics considered integral to an HSE MS. A significant conclusion was that a defective management system was the major issues. Specific factors mentioned by Cullen include:

- Organizational Structure
- Management personnel standards
- Training for operations and emergencies
- Safety assessments
- Design procedures
- Procedures for operations, maintenance, modifications, and emergencies
- Management of safety by contractors
- The involvement of the work force in safety
- Accident and incident reporting, investigation, and follow-up
- Monitoring and auditing of the operation of the system
- Systematic re-appraisal of the system in light of the experience of the operator and the industry.

Most organizations also agree that to assess HSE MS, an auditing approach should be used. This allows a way for different elements or factors to be quantified. Such quantification allows benchmarking, and thus a means for measuring performance and determining whether improvement is occurring. Some of the first people to suggest the use of some type of auditing scheme for evaluating safety management include Frank Bird (see Bird & Germain, 1985) and Dan Petersen (Petersen, 1982). The International Safety Rating System, ISRS, (Bird & Germain, 1985) has been developed as an auditing technique to provide a score on the quality of safety management. Petersen outlined accident causation models and mechanisms for system failures as well as assessment schemes for determining the quality of a company's safety management scheme in his book "Human Error Reduction and Safety Management" published in 1982. A third evaluation technique is the Instantaneous Fractional Annual Loss, IFAC, technique. It has been developed to indicate where there may be potential losses that could be attributable to safety management effectiveness (Whitehouse, 1987).

Other examples of SMS auditing approaches similar to those suggested by Bird, Petersen and Whitehouse include the following:

- The HSE safety auditing scheme (1985)
- Chemical Industries Auditing scheme (1977)
- DNV Technica's MANAGER Technique (Pitblado, et al. 1990)
- The Management Factor Technique (Powell & Canter, 1985)
- OSART programme (Bliselius & Franzen, 1985, Rosen 1988)
- OGP's Checklist for an Audit of Safety Management (1990)
- ABS Guide for Marine Safety, Quality and Environmental Management (April 2001).

A brief review of the elements of many of these techniques, as well as similar work by Boyen, Brandes, Burk & Burns (1987), Lees (1989) and Brian (1988) is provided in Harrison (1992). Further useful information about the origins of management system and the historical development of the associated concepts can be found in Bellamy & Geyer (1992).

From these early management systems, many industries or their related professional societies have developed their own guidance tools to match the unique needs of their applications. Given that different industries are served by different guidance and models, for the purposes of this paper, the E&P Forum (OGP) *Guidelines for the Development and Application of Health, Safety and Environmental Management Systems* approach has been chosen to explain how HF integrates with HSE MS. This model was chosen because it is an internationally accepted HSE MS approach for use by companies with offshore facilities. It combines the thought processes of both occupational health and safety (OHS) as well as process safety management (PSM) systems thinking.

According to the original document, the E&P Forum Guidelines for the Development and Application of Health, Safety and Environmental Managements Systems (1994) were developed to:

- Cover relevant HSE issues in a single document
- Be relevant to the activities of the E&P industry worldwide
- Be sufficiently generic to be adaptable to different companies and their cultures
- Recognize and be applicable to, the role of contractors and subcontractors
- Facilitate operation within the framework of statutory requirements
- Facilitate evaluation of operations to an international standard(s) as appropriate.

The Guidelines describe the main elements necessary to develop, implement and maintain an HSE MS. The detailed guidance can be obtained from the International Oil and Gas Producers website at www.ogp.org.uk. The elements, and a brief description of each, within the E&P Forum HSE MS are as presented in Table 2.

Table 2. E&P Forum HSE MS Elements

HSEMS Element	Descriptions
Leadership and Commitment	Top-down commitment and company culture, essential to the success of the system
Policy and Strategic Objectives	Corporate Intentions, principles of action and aspirations with regards to HSE
Organization, Resources and Documentation	Organization of people, resources and documentation for sound HSE performance
Evaluation and Risk Management	Identification and evaluation of HSE risks, for activities, products and services, and development of risk reduction measures
Planning	Planning the conduct of work activities, including planning for changes and emergency response
Implementation and Monitoring	Performance and monitoring of activities and how corrective action is to be taken when necessary
Auditing and Reviewing.	Periodic assessments of system performance, effectiveness and fundamental suitability.

The material above taken verbatim from the E&P Forum Guidelines document (1994).

The elements of the E&P Forum HSE MS model are very similar to the concepts of developing policy, organizing, planning and implementing; measuring and reviewing performance and auditing put forward in numerous OHS, SMS and TQM documents. This similarity further encouraged the authors to adopt the E&P Forum Model as a template for outlining the role of HF within HSE.

The graphical representation of the E&P Forum HSE MS is given is the Figure 3.

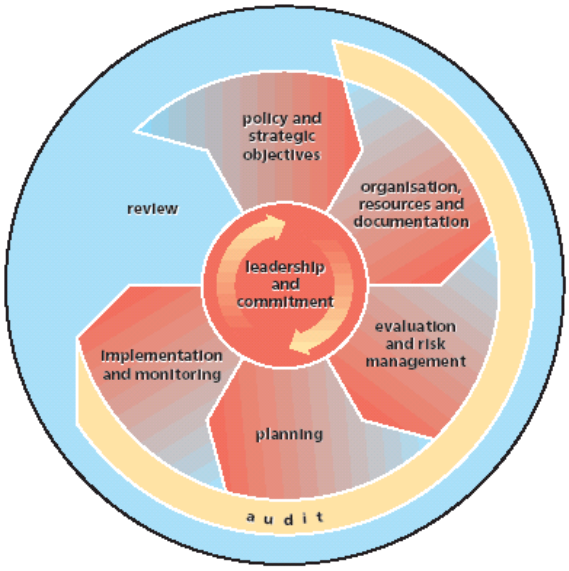

Figure 3. Graphic View of E&P Forum HSE MS Elements

2.0 INTEGRATION OF HF AND HSE MS

This paper introduces a notional life cycle process of HSE MS (see Figure 3) as presented in the E&P Forum Guidelines and then explains how HF principles and activities would integrate within that framework. Brief descriptions of the role of HF in each E&P HSE MS element are presented in Table 3:

Table 3. Role of HF in each E&P HSE MS Element

HSEMS Element	HF Role
Leadership and Commitment	The most important factor for the successful integration of HF within HSE MS is management leadership and commitment. It is through management declaring that integrating HF is an organizational goal and by providing the necessary resources for integration that success will occur. In addition, management must determine roles, responsibilities, accountabilities, and metrics in order that integration of HF in HSE takes place.
Policy and Strategic Objectives	Instilling Human (and Organizational) Factors objectives, principles, and processes through written policies and other high level documents with an HSE MS system design is necessary. The requirement associated with integrating HF as a part of HSE would also be documented here.
Organization, Resources and Documentation	Integrating HF principles within the HSE MS organization structure, ensuring adequate resources for HF will be provided and that HF requirements are documented is another important aspect of HF integration
Evaluation and Risk Management	Conducting ongoing assessments and measurements of HF within management processes is necessary for identifying, controlling, reducing the potential for human errors and for eliminating or mitigating their consequences.
Planning	In order for systematic identification and evaluation of human errors and their associated risks, human factors activities must be planned.
Implementation and Monitoring	Performing HF activities and monitoring HF functions during application of management processes is required to determine if efforts have been successful to reduce risks.
Auditing and Reviewing.	Utilizing HF processes for review, monitoring, and improvement of HSE MS is necessary to ensure continuous improvement.

The following tables discuss each of these major HSE MS elements in greater detail. For each HSEMS element, a table has been provided. Within each table, information from the E&P Guidelines is presented describing the intent of a particular HSE MS Element. The table is then sub-divided into sub-elements applicable to each HSE MS Element. For example, for the HSE MS Element of Policy and Strategic Objectives, the table is sub-divided into sections relating to the following:

- Policy Goals and Objectives
- Health, Safety and Environmental Policy
- Employee Participation.

For each sub-element, two questions relating to HF integration are posed, 1) How does Human Factors relate? And 2) What are the related Human Factors Tools/Activities? After such HF information is given, the final section of a table provides references for HF for the HSE MS element being discussed. The references are provided to allow the reader to seek additional information with regards to the integration of HF within particular HSE MS elements. The tables relating to how HF integrates within each E&P Forum HSE MS element are:

- Table 4, Leadership and Commitment
- Table 5, Policy and Strategic Objectives
- Table 6, Organization, Resources and Documentation
- Table 7, Evaluation and Risk Management
- Table 8, Planning
- Table 9, Implementation an Monitoring
- Table 10, Auditing and Reviewing.

Table 4. Leadership and Commitment

1.0 Leadership and Commitment, what is it according to the E&P Forum?
Senior management of the company should provide strong, visible leadership and commitment, and ensure that this commitment is translated into the necessary resources, to develop, operate and maintain the HSEMS and to attain the policy and strategic objectives. Management should ensure that full account is taken of HSE policy requirements and should provide support for local actions taken to protect health, safety and the environment. The company should create and sustain a company culture that supports the HSEMS, based on: • belief in the company's desire to improve HSE performance; • motivation to improve personal HSE performance; • acceptance of individual responsibility and accountability for HSE performance; • participation and involvement at all levels in HSEMS development; • commitment to an effective HSEMS. Employees of both the company and its contractors should be involved in the creation and maintenance of such a supportive culture.
1.1 HSE Vision and Mission
a. How Does Human Factors Relate to HSE Vision and Mission?
• Management influences safety culture (management/workforce attitudes) and attitudes about HFE integration and HFE integration into HSE including info engineering, design activities, incident investigation, management systems and procedures. • Management has responsibility to encourage safe behavior/discourage unsafe behavior. • It determines aims with regard to HFE in HSE. • Company leadership sets Policy and Goals, including those for HFE – including performance measures, reviewing corrective actions. It provides resources for implementing policy, plans, procedures, coaching with regards to HFE. • Management requires management responsibility for HFE and reporting on issues regarding HSE, as well as, assigns a champion (at highest level) with HFE responsibilities. • Management directs assessments to ensure the aim to integrate HFE into business practices is known throughout organization, and reviews results. The reviews include those related to audits, statistics, special study results.

b. What are the related Human Factors Tools/Activities for HSE Vision and Mission?

Inputs	HF Tools and Activities	HF Outputs
▪ Company's motivation to integrate HFE & HSE ▪ Previous HSE audit results ▪ HFE values and principles ▪ Principles of behavioral management ▪ Existing Senior Management leadership and commitment to HSE ▪ Existing HSE Policies and Strategies	▪ Needs Analysis for HFE in Company HSE Program	▪ Listing of HFE elements to be integrated in HSE ▪ Competent HFE resources ▪ Senior Management expectations ▪ HFE integration Vision and Mission

References for HF within Leadership & Commitment:

- Alexander & Pulat (1985)
- Chapanis (1996)
- Harrison (1992)
- Petersen (1982)
- Bird & Germain (1985)
- Geller (1995)
- Krause (1997)
- Schwartz (Ed., 2000)

Table 5. Policy & Strategic Objectives

2.0 Policy & Strategic Objectives, what are they according to the E&P Forum?
The company's management should define and document its HSE policies and strategic objectives and ensure that they: - are consistent with those of any parent company; - are relevant to its activities, products and services, and their effects on HSE; - are consistent with the company's other policies; - have equal importance with the company's other policies and objectives; - are implemented and maintained at all organizational levels; - are publicly available; - commit the company to meet or exceed all relevant regulatory and - legislative requirements; - apply responsible standards of its own where laws and regulations do not exist; - commit the company to reduce the risks and hazards to health, safety - and the environment of its activities, products and services to levels which are as low as reasonably practicable; - provide for the setting of HSE objectives that commit the company to - continuous efforts to improve HSE performance. The company should establish and periodically review strategic HSE objectives. Such objectives should be consistent with the company's policy and reflect the activities, relevant HSE hazards and effects, operational and business requirements, and the views of employees, contractors, customers and companies engaged in similar activities. Sub-elements for Policy & Strategic Objectives include: ▪ Policy Goals and Objectives ▪ Health Safety and Environmental Policy ▪ Employee Participation.

2.1 Policy Goals and Objectives

a. How Does Human Factors Relate to Policy Goals and Objectives?

- Clearly defined goals and objectives for HFE in HSE should be documented (for all workers and managers).
- A policy is needed to set the tone, as well as, the requirement for integration of HFE.
- The objectives of HFE, including performance criteria, should be documented.

b. What are the related Human Factors Tools/Activities for Policy Goals and Objectives?

Inputs	HF Tools and Activities	HF Outputs
▪ Existing HSE Policies and Strategies ▪ Previous HSE audit results ▪ HFE values and principles ▪ Human performance capabilities and limitations	▪ Develop HFE integration Vision and Mission statements ▪ Provide operational definitions for HFE integration elements • Define HFE/HSE integrated elements	▪ Written HFE integration objectives ▪ High-level management/employee expectations ▪ Human performance objectives ▪ HFE Implementation Plan (HFIP)

2.2 Health, Safety and Environmental Policy

a. How Does Human Factors Relate to Health, Safety and Environmental Policy?

- Clearly defined goals for HFE in HSE should be documented (for all worker and managers) within the HSE Policy.
- These goals will set the tone for integration of HFE.

b. What are the related Human Factors Tools/Activities for Health, Safety and Environmental Policy?

Inputs	HF Tools and Activities	HF Outputs
▪ Existing HSE Policies and Strategies ▪ HFE Vision, Mission, and Objectives ▪ HF values and principles ▪ High-level personnel (management and employee) expectations ▪ Company's desire and motivation to incorporate HFE into HSE	▪ Operational definitions for HFE integration elements ▪ Determine HFE/HSE integrated elements ▪ Development of an HFE Implementation Plan ▪ Ergonomics/human factors engineering principles	▪ Specific HFE expectations by management/employees ▪ Input into roles, responsibilities, and accountabilities for HFE/HSE ▪ HFE performance goals and measures ▪ Credentials and Certification Information for HFE Personnel

2.3 Employee Participation

a. How Does Human Factors Relate to Employee Participation?

- Someone representing HFE should be included on HSE Committee.
- Employees on the HSE Committee should be made aware of the role, vision, mission, goals and objectives for HFE.
- Participation of both managers and employees in Behavioral-Based Safety (safe/unsafe acts) programs and also participate in risk, hazard, safety and environmental studies as team members or reviewers is needed to ensure input from management and employees with regard to HFE issues
- Suggestion Programs for HFE, as well as for HSE and productivity concerns.
- Employees should participate in Goal Setting activities for HFE in HSE.
- Employees are empowered to stop or refuse a task when HSE concerns, including those related to HFE, exists with the execution of a task.

b. What are the related Human Factors Tools/Activities for Employee Participation?

Inputs	HF Tools and Activities	HF Outputs
▪ Existing HSE policies and strategic objectives ▪ HFE Vision, Mission, and Objectives ▪ Behavior based safety process feedback ▪ Incident and near miss data	▪ Roles, responsibilities, and accountabilities for HFE/HSE ▪ Review of HFE Performance Goals and Measures with regard to employee feedback, behavioral based safety program results, incident / near miss reports ▪ Working/safety culture assessment ▪ Interviews and questionnaires ▪ Suggestion programs	▪ Specific HFE expectations by employees ▪ Employee roles and responsibilities for HFE/HSE ▪ Defined feedback mechanisms for HFE/ HSE issues ▪ Updates to HFE Policies, Programs, Plans or to Behavior Based Safety Programs or Incident /Near Miss Reporting Schemes

References for HF within Policy & Strategy:

- Chapanis. (1996)
- Alexander & Pulat (1985)
- McSween (1995)
- Petersen (1982)
- Schwartz (Ed., 2000)
- Nordin, Et. Al. (1997)

Table 6. Organization, Resources and Documentation

3.0 Organization, Resources and Documentation, what is it according to the E&P Forum?
Successful handling of HSE matters is a line responsibility, requiring the active participation of all levels of management and supervision; this should be reflected in the organizational structure and allocation of resources. The company should define, document and communicate—with the aid of organizational diagrams where appropriate—the roles, responsibilities, authorities, accountabilities and interrelations necessary to implement the HSEMS, including but not limited to: • provision of resources and personnel for HSEMS development and implementation; • initiation of action to ensure compliance with HSE policy; • acquisition, interpretation and provision of information on HSE matters; • identification and recording of corrective actions and opportunities to improve HSE performance; • recommendation, initiation or provision of mechanisms for improvement, and verification of their implementation; • control of activities whilst corrective actions are being implemented; • control of emergency situations. The company should stress to all employees their individual and collective responsibility for HSE performance. It should also ensure that personnel are competent (see section 3.4) and have the necessary authority and resources to perform their duties effectively. The organizational structure and allocation of responsibilities should reflect the responsibility of line managers at all levels for developing, implementing and maintaining the HSEMS in their particular areas. The structure should describe the relationships between: • Different operating divisions • Operating divisions and supporting services (whether the services are provided on the same facility or from a larger corporate organization) • Onshore and offshore organizations • Employees and contractors • Partners in joint activities.

Sub-elements for Organization, Resources and Documentation include:

- Organizational Structure and Responsibilities
- Management Representatives
- Resources
- Training & Competency Systems
- Contractors
- Communications
- Documentation and its control.

3.1 Organizational Structure and Responsibilities

a. How Does Human Factors Relate to Organizational Structure and Responsibilities?

- Determines where responsibility for and reporting on HFE occurs in Management structure. HFE responsibilities and reporting requirements would be highlighted in the appropriate managers' job descriptions.
- To check if changes are needed for this area, periodic review of audit finding, incident / accident investigations, near miss reports, HFE tasks and progress should occur.
- The organizational structure should be such that there is an independence of HSE and production functions and reporting.
- As a part of this concern, command structure for incidents and accidents relating to HFE should be defined. Also authorities and responsibilities for HFE in HSE should be defined.
- In particular, areas of concern that fall under the organizational structure and responsibilities include chain of command, span of control, delegation of authority, responsibilities, staff accountability for safety at all levels (see Petersen, 1982).

b. What are the related Human Factors Tools/Activities for Organizational structure and responsibilities?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ HFE Mission, Vision, and Objectives ▪ HSE Policies and Strategies ▪ HFE Implementation Plan ▪ Roles, responsibilities, and accountabilities for HFE/HSE ▪ Feedback mechanisms for HFE/ HSE issues ▪ Personnel (management and employee) expectations	▪ Organizational communications evaluation ▪ Review / update HFE performance goals and measures ▪ Review/Update Human performance objectives ▪ Ergonomics/human factors engineering principles	▪ HFE Strategy ▪ HFE performance targets ▪ Assignment of HFE Objectives to various parts of the organization ▪ Defined HFE job functions, requirements and reporting responsibilities ▪ Job Descriptions for HFE Personnel

3.2 Management Representatives

a. How Does Human Factors Relate to Management Representatives?

- Determining human factors needs for managing work processes.
- Establishing and maintaining communications between employees and management.
- Verifying process planning, organizing, implementing and controlling activities that are a part of work processes.
- Identifying training needs.
- Identifying performance criteria for continuous improvement.

b. What are the related Human Factors Tools/Activities for Management Representatives?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ HFE Objectives of various parts of the organization ▪ Identification of a management representative for HFE Champion ▪ HFE Strategy ▪ HFE performance targets ▪ Specific HFE expectations by management	▪ Job task analysis of HFE Champion ▪ HFE job functions, requirements and reporting responsibilities defined ▪ Roles, responsibilities, and accountabilities for HFE/HSE determined	▪ Position Description for HFE Champion ▪ Assignment of HFE Objectives to various departments and managers ▪ HFE Champion job functions, qualifications, requirements and reporting responsibilities

3.3 Resources

a. How Does Human Factors Relate to Resources?

- Task analysis including Task dependencies analysis can be used to determine what individuals and department and other resources are involved in the conduct of HFE tasks, their responsibilities, risks.
- Some HFE concerns. under resources, include the number of daily shifts for a location, the length of shifts, the beginning and ending times of the shifts, as well as staffing levels for an installation. All are interrelated.
- Using task analysis for evaluating critical operations and maintenance tasks or emergency / contingencies plans, equipment, tools can be identified that would be required for safe, efficient conduct of tasks. This analysis would also identify the number of persons needed to complete the task, communications requirements, lifting needs where equipment mounted instructions might be required to aid in the conduct of tasks, etc.

b. What are the related Human Factors Tools/Activities for Resources?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ HFE Implementation Plan ▪ Job Descriptions for HFE Personnel, including Champion ▪ Credentials and Certification Information for HFE Personnel ▪ Reports of HFE activities and effectiveness ▪ HSE/HFE audit results ▪ Feedback mechanisms for HFE/ HSE issues	▪ Job task analyses for HFE personnel ▪ Incident, accident, and near miss data ▪ Human performance objectives ▪ Ergonomics/human factors engineering principles ▪ Personnel knowledge, skills, and ability standards	▪ Update/input into roles, responsibilities, and accountabilities for HFE/HSE ▪ Update/input into job descriptions for HFE Personnel ▪ HFE performance indicators ▪ Update/input into personnel knowledge, skills, and ability standards

3.4 Training/Competence System
a. How Does Human Factors Relate to Training/Competence System?
• For both identifying training needs and competencies, job / task analysis can be used. Analysis should be restricted to critical tasks. Results would be documented, preferably in a data-based system for tracking and updating purposes. • Using task analysis, training needs could be determined for Initial or Indoctrination training, HFE training, emergency training needs, including spills, fire, explosion, abandon platform, man overboard, weather contingencies as well as identifying operations and maintenance training. • This approach could determine who would be trained for different needs and the extent of that training. • The task analysis method could also help with identifying learning objectives associated with different types of training. • Using information about learning styles, from psychological research, training methods could be assessed to determine the method to use for different training needs (Classroom, computer based, lecture, on the job, in the laboratory or workshop, etc.) • Human factors principles could also be applied to determining what records should be kept and in what form. • Job / Task Analysis can be used to assess required competencies for different jobs. Such analysis can identify critical skills, knowledge, aptitudes, experience, decision-making abilities associated with a particular position, including human factors specialists. • Analyses of the requirements for particular jobs may also point out the need for including psychometric testing for certain positions. For example, test for color and depth perception for crane operators, hearing tests for persons using communications equipment, strength testing for jobs requiring heavy lifting, etc. Other positions may require testing for behavioral tendencies like risk taking. • Information from the Job / Task analyses can be used to create job descriptions. • Using information defined to establish competencies, review of performance for individuals is possible based on objective criteria. An appraisal method can be created based on such criteria. • A system should be created for tracking competencies. The system could allow self evaluation by employees as well as evaluation by supervisors and managers.

b. What are the related Human Factors Tools/Activities for Training/Competence System?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing company awareness training procedures and methodologies for HSE ▪ Existing company review/training procedures for the maintenance of HSE knowledge, skills, and abilities ▪ Human performance limitations/ capabilities ▪ Incident, accident, and near miss reports ▪ HFE Implementation plan ▪ HFE Strategy ▪ Feedback from training classes ▪ Performance evaluations of personnel	▪ Training requirements and needs assessment ▪ Gap Analysis for HFE training ▪ HFE awareness training goals ▪ Training needs analysis for renewal or refresher training ▪ Validation and verification exercise for training ▪ Instructional systems development process ▪ Psychometric and personality tests	▪ Update/input into human performance standards ▪ Learning objectives for HFE related to awareness training ▪ HFE training requirements and evaluations ▪ HFE competency assessment tools

3.5 Contractors (and Procurement)

a. How Does Human Factors Relate to Contractors (and Procurement)?

- In terms of HFE in HSE, it would be important to determine if contractors have systems for reducing the potential for human errors in their work processes. For example,
  - do they have an HSE policy?
  - Is there an incident / accident / near miss reporting system?
  - Is there a tracking system for these and also for injury statistics, fines, environmental violations?
  - Is there a log of overtime hours? Has analysis been done to determine if overtime increases, are accidents, injuries and near misses also increasing?
  - Another issue to examine is how are personnel selected for their jobs. Does a systematic means for evaluating skills and knowledge for various jobs exist?
- In choosing and procuring vendor-supplied equipment, a selection criteria for a vendor can be to choose a vendor that has used HFE in the design of equipment. An alternative is to have a staff member evaluate different equipment package for adherence to HFE criteria and then use this evaluation as an input to selecting equipment.

b. What are the related Human Factors Tools/Activities for Contractors (and Procurement)?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing Company procedures with respect to Contractor selection ▪ Existing Company procedures with respect to Contractor training requirements ▪ Existing Company procedures with respect to monitoring the Contractor's performance ▪ Existing Company procedures with respect to assessing the Contractor's performance ▪ Incident, accident, and near miss data ▪ Roles, responsibilities, and accountabilities for HFE/HSE	▪ Human performance standards ▪ Learning objectives for HFE related to awareness training ▪ HFE training requirements and evaluations ▪ HFE competency assessment ▪ HFE Vision, Mission, and Objectives ▪ HFE Implementation Plan ▪ HFE targets	▪ Contractor learning objectives for HFE related to awareness training ▪ Contractor HFE training requirements and evaluations ▪ Contractor HFE competency assessment tools ▪ Update/input into roles, responsibilities, and accountabilities for HFE/HSE with respect to Contractors ▪ Update/input into HFE Vision, Mission, and Objectives for Contractors

3.6 Communications

a. How Does Human Factors Relate to Communications?

- One means to reduce human error and communications problems is to create pre-planned communications protocols for both written and verbal communications. These protocols would exist for telephone, loudspeaker and radio communications. Report forms could be created for written communications, including things like daily operations reports, work permits, maintenance requests, order forms, drilling data, etc.
- For particular types of communications, there should be defined communications devices and channels. These would include marine, helicopter, crane communications. For these instances, defining terminology to be used in communications would be important. For example, IMO speak might be used for marine communications, aviation terms for helicopters.
- An organizational communications study could be conducted to track information flow and requests to improve forms and where possible reduce reporting requirements. This would include a review of shift logs, permitting systems, shift turnover practices/protocols, and other written request / reporting forms.

b. What are the related Human Factors Tools/Activities for Communications?		
Inputs	**HF Tools and Activities**	**HF Outputs**
Existing Company procedures for communications ▪ Incident, accident, and near miss data ▪ HSE/HFE audit results ▪ Constrained Language Lists IMO Speak for Communications with marine vessels ▪ Phonetic alphabets	▪ Job task analysis ▪ Link analysis ▪ Phonetic speech intelligibility tests	▪ Update/input into communication protocols ▪ Update/input into personnel evaluation and selection tools ▪ Update/input into personnel knowledge, skills, and ability standards
3.7 Documentation and its Control		
a. How Does Human Factors Relate to Documentation and its control?		
• Human factors evaluations should be integrated into all formal HSE/ hazard/risk studies. As part of these studies, potential human errors should be identified and analyzed and means for error reductions should be suggested. Implementation of results should be tracked. • Employees should be included in all HSE/hazard/risk studies as subject matter experts. • Where appropriate, human reliability analysis techniques should be applied to evaluate risks and hazards.		

b. What are the related Human Factors Tools/Activities for Documentation and its control?		
Inputs	**HF Tools and Activities**	**HF Outputs**
Existing Company documentation control policies (this includes availability, distribution, and dissemination methodologies) Existing Company documentation maintenance policies (for example updates relating to changes in things like Company policies, procedures, or legislative/regulatory requirements) ▪ Incident, accident, and near miss data	▪ User interviews and questionnaires ▪ Information mapping techniques ▪ Feedback mechanisms for HFE issues	▪ Update/input into documentation format and visual presentation methodologies ▪ HFE value added to documentation accuracy and usability

References for HF within Organization, Resources, and Documentation:

- Chapanis (1996)
- Alexander & Pulat (1985)
- Schwartz, G. (Ed., 2000)
- Landy & Trumbo (1980)
- Karwowski & Marras (Eds., 1998)

Table 7. Evaluation and Risk Management

4.0 Evaluation and Risk Management, what is it according to the E&P Forum?

The company should maintain procedures to **identify** systematically the hazards and effects that may affect or arise from its activities, and from the materials which are used or encountered in them. The scope of the identification should cover activities from inception (e.g. prior to acreage acquisition) through to abandonment and disposal. The identification should include consideration of:
 	
• Planning, construction and commissioning (i.e. asset acquisition, development and improvement activities).
• Routine and non-routine operating conditions, including shut-down, maintenance and start-up.
• Incidents and potential emergency situations, including those arising from:
  - Product/material containment failures.
  - Structural failure.
  - Climatic, geophysical and other external natural events.
  - Sabotage and breaches of security.
• Human factors including breakdowns in the HSEMS.
• Decommissioning, abandonment, dismantling and disposal.
• Potential hazards and effects associated with past activities.
 	
Personnel at all organizational levels should be appropriately involved in the identification of hazards and effects.
 	
The sub-elements associated with Evaluation and Risk Management are as follows:
• Identification of Hazards and Effects
• Evaluation
• Recording of hazards and effects
• Objectives and performance criteria
• Risk reduction measures

4.1 Identification of Hazards and Effects

a. How Does Human Factors Relate to Identification of hazards and effects?

- Human factors evaluations should be integrated into all formal HSE/ hazard/risk studies. As part of these studies, potential human errors should be identified and analyzed and means for error reductions should be suggested. Implementation of results should be tracked.
- Employees should be included in all HSE/hazard/risk studies as subject matter experts.
- Where appropriate, human reliability analysis techniques should be applied to evaluate risks and hazards.

b. What are the related Human Factors Tools/Activities for Identification of hazards and effects?

Inputs	HF Tools and Activities	HF Outputs
▪ Incident, accident, and near miss data ▪ Communication protocols ▪ Existing Company HSE policies and strategic objectives ▪ Human performance limitations/ capabilities ▪ Human performance risks ▪ Behavior based safety feedback ▪ Principles of behavioral management ▪ Review of routine, non-routine, and emergency O&M procedures and policies	▪ Human error identification techniques ▪ Behavioral based safety programs ▪ Job task analysis ▪ Link analysis ▪ HFE Implementation Plan ▪ Ergonomics/human factors engineering principles ▪ Human performance standards	▪ Update/input into ergonomics/ HFE guidance and specifications ▪ Update/input into personnel evaluation and selection tools ▪ Update/input into personnel knowledge, skills, and ability standards ▪ Update/input into personnel job descriptions ▪ Update/input into hazard identification techniques

4.2 Evaluation

a. How Does Human Factors Relate to Evaluation?

- To assess hazard and risk controls, routine inspections and reporting on the inspections should be required – workplace, equipment, housekeeping. In additions, reviews of near miss and accident reports as well as behavioral based safety studies.
- A mechanical integrity program can help to control maintenance risks and failures. Periodic review of maintenance records and readings may also reveal potential problems.

b. What are the related Human Factors Tools/Activities for Evaluation?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Incident, accident, and near miss data ▪ Communication protocols ▪ Existing Company HSE policies and strategic objectives ▪ Human performance limitations/ capabilities ▪ Human performance risks ▪ Review of routine, non-routine, and emergency O&M procedures and policies	▪ Human error analysis techniques ▪ Human reliability analysis ▪ Job task analysis ▪ Ergonomics/human factors engineering principles ▪ Human performance standards	▪ Update/input into ergonomics/ HFE guidance and specifications ▪ Update/input into personnel knowledge, skills, and ability standards ▪ Update/input into personnel job descriptions ▪ Update/input into hazard evaluation techniques

4.3 Recording of Hazards and Effects

a. How Does Human Factors Relate to Recording of hazards and effects?

- A hazard log can be used to record potential hazards including those related to HFE.
- Risk assessment reports and work sheets can be used to include use of HFE as a layer of protection.
- Include HRA in Risk Assessments.
- Hazards analysis recommendation to include HFE improvements.

b. What are the related Human Factors Tools/Activities for Recording of hazards and effects?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Incident, accident, and near miss data ▪ Existing Company HSE policies and strategic objectives ▪ Existing Company hazard reporting and recording system ▪ Existing Company routine O&M procedures and policies ▪ Existing Company non-routine and emergency operating procedures ▪ Existing Company Risk Assessments, Reports, Analyses Data ▪ Hazards Analysis Worksheets	▪ User interviews and questionnaires ▪ Information mapping techniques ▪ Feedback mechanisms for HSE/HFE issues ▪ Learning objectives for HFE related to awareness training ▪ HFE training requirements and evaluations ▪ Layer of Protection Analyses including HFE ▪ HRA methods ▪ Program for HFE Recommendations, Resolutions and Follow-up	▪ Update/input into hazard recording procedures ▪ Update/input into hazard recording forms or checklists ▪ Update/input into documentation format and visual presentation methodologies ▪ Update / input Risk assessment worksheets and checklists ▪ Resolve PHA recommendations including HFE items

4.4 Objectives and Performance Criteria
a. How Does Human Factors Relate to Objectives and Performance Criteria?
• Performance standards setting for HFE • Policy document developments for HFE • Strategic planning for HFE

b. What are the related Human Factors Tools/Activities for Objectives and Performance Criteria?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Incident, accident, and near miss data ▪ Human performance capabilities and limitations ▪ Performance evaluations of personnel ▪ Personnel (employee and management) roles and responsibilities for HFE/HSE ▪ Strategic Planning Objectives for HFE	▪ User interviews and questionnaires ▪ Job task analyses ▪ Human performance standards ▪ Personnel evaluation and selection tools ▪ Personnel knowledge, skills, and ability standards ▪ Policy documents for HFE	▪ Update/input into key performance indicators ▪ Update/input into procedures to set performance criteria ▪ Updated policies

4.5 Risk Reduction Measures

a. How Does Human Factors Relate to Risk Reduction Measures?

There are many ways that integrating HFE into HSE can reduce risks. The most appropriate application for HFE is the development of an HFE integration program that requires the systematic evaluation of interfaces and work processes for potential human factors concerns. Some factors that can be considered include:

- Designated smoking areas
- Lighting – night operations
- Program to reduce hazardous waste – labeling, handling instructions, methods
- Testing for depth, crane operations, labeling work permits, confined space, color vision
- Training and simulation for EER, spills, etc.
- Human Factors as part of design – anthrop – HMI – layouts – equipment/tool design
- HFE in risk studies
- Rules (mechanical integrity program)
- PPE selection, use, inspection
- HFE in design
- HFE in operations, maintenance
- HFE in procedures, labels, drills, SEMP, OHS, signs, labels
- Behavior based safety

b. What are the related Human Factors Tools/Activities for Risk Reduction Measures?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Incident, accident, and near miss data ▪ Existing Company HSE policies and strategic objectives ▪ Existing Company hazard reporting system ▪ Existing Company procedures regarding risk reduction ▪ Existing Company routine O&M procedures and policies ▪ Existing Company non-routine and emergency operating procedures ▪ Behavior tendency data	▪ Behavioral based safety programs ▪ Psychological testing for personnel risk behavior ▪ Testing for depth perception and color deficiency ▪ Testing for hearing for those using voice communications equipment ▪ Human error analysis techniques ▪ Human reliability analysis ▪ Job task analyses ▪ Ergonomics/human factors engineering principles ▪ Human performance capabilities and limitations	▪ Update/input into ergonomics/ HFE guidance and specifications ▪ Update/input into personnel evaluation and selection tools/criteria ▪ Update/input into personnel knowledge, skills, and ability standards ▪ Specific HFE input into Company O&M, EER, HSE Documentation

References for HF within Evaluation and Risk Management:

- AicheE (1994)
- Gertman and Blackman (1994)
- Kirwan & Ainsworth (1992)
- Meister (1985)
- Reason (1997)
- Salvendy (1997)
- Wilson & Corlett (1990)
- Eastman Kodak (1983 / 1986)
- Grandjean (1988)
- Kirwan & Ainsworth (1992)
- Nordin, et. al. (1997)
- Salvendy (1997)
- Schwartz (Ed., 2000)

Table 8. Planning

5.0 Planning, what is it according to the E&P Forum?
The company should maintain, within its overall work program, plans for achieving HSE objectives and performance criteria. These plans should include: - a clear description of the objectives; - designation of responsibility for setting and achieving objectives and performance criteria at each relevant function and level of the organization; - the means by which they are to be achieved; - resource requirements; - time scales for implementation; - programs for motivating and encouraging personnel toward a suitable HSE culture; - mechanisms to provide feedback to personnel on HSE performance; - processes to recognize good personal and team HSE performance (e.g. safety award schemes); - mechanism for evaluation and follow-up. The sub-elements that relate to Planning are as follows: - General - Asset Integrity - Procedures and Work Instructions - Management of Change - Contingency and Emergency Planning.
5.1 General
a. How Does Human Factors Relate to planning in General?
• Treatment of safety critical items • Operations and maintenance of philosophies to include text requiring operability and maintainability be addressed by applying human factors engineering criteria to the design of equipment, skids, access/egress routes, alarms, announcements, etc. • Use of HFE in Quality Assurance Programs for procurement, fabrication, installation, production and decommissioning • Use of HFE attributes in qualifying contract personnel in the planning process.

b. What are the related Human Factors Tools/Activities for planning in General?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Previous HSE audit results ▪ HFE values and principles ▪ Existing HSE Policies and Strategies ▪ Existing Company plan to achieve HSE objectives and performance criteria ▪ Existing Company policy to maintain HSE objectives and performance criteria	▪ HFE integration Vision, Mission, and Objectives ▪ Operational definitions for HFE integration elements ▪ HFE/HSE integrated elements ▪ HFE Implementation Plan ▪ Identify HFE requirements for Contractor Qualification Programs	▪ Update/input into management/ employee expectations ▪ Update/input into human performance objectives ▪ Update/input into HFE performance goals and measures ▪ Update/input into roles, responsibilities, and accountabilities for HFE/HSE ▪ Updated Contractor Qualification Programs
5.2 Asset Integrity		
a. How Does Human Factors Relate to Asset Integrity?		
• Documentation of Operations and Maintenance activities including HFE evaluations of interfaces, work processes, tools, procedures, etc. • Inspection (routine and non-routine) of work areas for safety and ergonomics concerns • Evaluation of procurement, fabrication and installation processes for checking that HFE as been addressed in these areas • QA/QC include HFE checks		

b. What are the related Human Factors Tools/Activities for Asset Integrity?		
Inputs	**HF Tools and Activities**	**HF Outputs**
Existing Company procedures relating to asset integrity (e.g., procedures to ensure that HSE-critical facilities/equipment are suitable for their required purpose) Existing Company procedures related to achieving HSE objectives ▪ Previous HSE audit results Incident, accident, and near miss data ▪ Existing Company routine O&M procedures and policies ▪ Existing Company non-routine and emergency operating procedures ▪ Existing Company QA program	▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles ▪ HFE/HSE integrated elements ▪ Job task analyses ▪ Learning objectives for HFE related to awareness training ▪ HFE training requirements and evaluations ▪ QA checklist	▪ Specific HFE input into Company O&M, EER, HSE Documentation ▪ Update/input into ergonomics/ HFE guidance and specifications ▪ Update/input into personnel knowledge, skills, and ability standards ▪ Update/input into documentation format and visual presentation methodologies ▪ HFE value added to documentation accuracy and usability ▪ Update QA checklist to include HFE criteria

5.3 Procedures and Work Instructions
a. How Does Human Factors Relate to Procedures and Work Instructions?
• Coverage of documents with regard to tasks where human error potentials are high • Reviews for quality of documents • Written processes for updating, distribution • Evaluation of procedures and work instructions for suitability for users. Procedures have requirements stating that there must be periodic reviews, revisions • There should be a formal means for staff to comment procedures and work instructions • Work permit system should be designed such that forms are easy to use, the work permit requirements are clear, and that an assessment for the potential for human errors is conducted in job planning associated with the permitted tasks • Standards exist to set performance requirements on tasks. This would include criteria related to document layout, wording, type of instruction, flowchart use, prose guidelines, checklist use, etc. • Procedures and work instructions should be up to date and written in a clear and usable format. (for example, use of information mapping to ensure tasks are broken into understandable portions) • Verification and validation exercises should be required to test usability and validity of written procedures and instructions • Revision cycle should be defined for all documents • Procedures and Work Instructions should be updated in conjunction with Management of Change processes

b. What are the related Human Factors Tools/Activities for Procedures and Work Instructions?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing Company HSE policies and strategic objectives ▪ Existing Company routine, non-routine and emergency policies and procedures ▪ Incident, accident, and near miss data ▪ Previous HSE audit results ▪ Existing Company Quality System documentation	▪ User interviews and questionnaires ▪ Information Mapping Techniques ▪ Feedback mechanisms for HFE/HSE issues ▪ Training requirement's evaluation ▪ Human performance capabilities and limitations ▪ Behavioral based safety programs	▪ Update/input into existing Company HSE policies and strategic objectives ▪ Update/input into existing Company routine, non-routine and emergency policies and procedures ▪ Update/input into existing Company Quality documentation ▪ HFE value added to documentation accuracy and usability ▪ Update/input into documentation format and visual presentation methodologies

5.4 Management of Change		
a. How Does Human Factors Relate to Management of Change?		
• MOC Documentation, authorization and review procedures include HFE requirements • MOC document tracking and monitoring includes HFE concerns		
b. What are the related Human Factors Tools/Activities for Management of Change?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing Company procedures for planning and controlling changes ▪ Existing Company HSE policies and strategic objectives ▪ Incident, accident, and near miss data ▪ Previous HSE audit results ▪ Existing program to track, monitor and follow-up on changes	▪ User interviews and questionnaires ▪ Feedback mechanisms for HFE/HSE issues ▪ Identify HFE items for MOC checklists or forms	▪ Update/input into existing Company HSE policies and strategic objectives ▪ Update/input into existing Company change procedures ▪ HFE value added to documentation accuracy and usability ▪ Specific HFE input into Company O&M, EER, HSE Documentation ▪ Updated MOC checklists or forms to include HFE items

5.5 Contingency and Emergency Planning

a. How Does Human Factors Relate to Contingency and Emergency Planning?

Thorough consideration of HFE in Contingency and Emergency Planning is necessary to avoid human errors that could worsen the escalation or consequences of events during unusual circumstances. Some areas that should be considered include:

- Declaration of emergency (criteria) (method defined). Provision of an emergency control center for centering response activities. Protocols for contingencies and emergencies should be defined using operational terms and tests of these should occur to determine usability of the approach.
- Emergency response manuals should include clear and concise instructions for events such as man overboard, fire, explosion, collision, spills, etc. Other areas of operations that should be reviewed for potential HFE problems include:
    - Wave actions
    - Weather
    - Sea conditions
    - Marine operations
    - Drilling
    - SIMOPS.
- Exercises should be conducted to test the usability of the instruction and ensure that all necessary equipment has been defined and is available.
- Availability of information during emergencies should be assessed to determine if people have necessary info in a timely manner.
- Defined command structures should be include in response procedures.
- Job Task Analyses should be used to define roles, responsibilities, facilities and tools required.
- From the HFE literature, behavioral information on people in emergencies should be used as inputs to developing response procedures.
- Developing root cause analysis method should occur during planning in order to allow systematic evaluations of potential causes and also weaknesses in HSE, in case of incidents
- Simulation and monitoring of human behavioral response in emergency drills can be used to discover and address potential problem during emergencies
- Records of drills and notations of problems/concerns should be kept and periodically evaluated.
- HFE personnel should provide input on the location of platform shutdown and ESD stations throughout a platform, as well as on the design of Hydrogen Sulfide alarms and beacons.

b. What are the related Human Factors Tools/Activities for Contingency and Emergency Planning?

Inputs	HF Tools and Activities	HF Outputs
▪ Existing Company non-routine and emergency operating procedures ▪ Personnel roles and responsibilities for HFE/HSE ▪ Feedback mechanisms for HFE/HSE issues ▪ Roles, responsibilities, and accountabilities for HFE/HSE ▪ Communication protocols ▪ Existing Company HSE policies and strategic objectives ▪ Incident, accident, and near miss data ▪ Previous HSE audit results ▪ Principles of behavioral management	▪ User interviews and questionnaires ▪ Personnel knowledge, skills, and ability standards ▪ HFE Design Standards ▪ Psychological testing for personal risk taking behavior ▪ Human performance capabilities and limitations ▪ Training requirements evaluation	▪ Update/input into existing Company non-routine and emergency operating procedures ▪ Update/input into roles and responsibilities for Company personnel ▪ Update/input into key performance indicators ▪ Update/input into procedures to set performance criteria ▪ Update/input into communication protocols ▪ Update/input into existing Company HSE policies and strategic objectives

References for HF within Planning:

- AicheE (1994)
- Karwowski & Marras (Eds., 1998)
- Schwartz, G. (Ed., 2000)
- Eastman Kodak (1983 / 1986)
- McSween (1995)
- Wilson & Corlett (1990)

Table 9. Implementation and Monitoring

6.0 Implementation and Monitoring, what is it according to the E&P Forum?
Activities and tasks should be conducted according to procedures and work instructions developed at the planning stage—or earlier, in accordance with HSE policy: - At senior management level, the development of strategic objectives and high-level planning activities should be conducted with due regard for the HSE policy. - At supervisory and management level, written directions regarding activities (which typically involve many tasks) will normally take the form of plans and procedures. - At the work-site level, written directions regarding tasks will normally be in the form of work instructions, issued in accordance with defined safe systems of work (e.g. permits to work, simultaneous operations - procedures, lock-off procedures, manuals of permitted operations). Management should ensure, and be responsible for, the conduct and verification of activities and tasks according to relevant procedures. This responsibility and commitment of management to the implementation of policies and plans includes, amongst other duties, ensuring that HSE objectives are met and that performance criteria and control limits are not breached. Management should ensure the continuing adequacy of the HSE performance of the company through monitoring activities (see section 6.2). The sub-elements related to Implementation and Monitoring are as follows ▪ Activities and Tasks ▪ Monitoring ▪ Records ▪ Non-compliance and Corrective Actions ▪ Incident Reporting ▪ Incident Follow-up

6.1 Implementation and Monitoring Activities and Tasks

a. How Does Human Factors Relate to Activities and Tasks?

- HFIP would describe HFE planned HFE activities for the various parts of the installation's life cycle.
- Simulations of emergency, spills, other emergency drills
- Awareness training for HFE
- Toolbox talks on HFE related topics

b. What are the related Human Factors Tools/Activities for Activities and Tasks?

Inputs	HF Tools and Activities	HF Outputs
▪ Personnel roles and responsibilities for HFE/HSE ▪ Feedback from mechanisms for HFE/ HSE issues ▪ Previous HSE audit results ▪ Existing Company policies and procedures including HSE ▪ Human performance objectives ▪ Existing Senior Management leadership and commitment to HSE ▪ Incident, accident, and near miss data ▪ HFE integration Vision, Mission, and Objectives	▪ HFE values and principles ▪ HFE Implementation Plan ▪ HFE Strategy ▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles	▪ Update/input into Senior Management expectations ▪ Update/input into management/employee expectations ▪ Update/input into roles, responsibilities, and accountabilities for HFE/HSE ▪ Update/input into HFE integration Vision, Mission, and Objectives

6.2 Monitoring

a. How Does Human Factors Relate to Monitoring?

Monitoring is necessary to demonstrate that HFE activities are having the desired effects and results. One means is to require that performance standards and measures be periodically checked. HFE criteria should also be reviewed to ensure it is current and applicable or where gaps in criteria might exist.

b. What are the related Human Factors Tools/Activities for Monitoring?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing Company procedures for monitoring HSE performance ▪ Personnel roles and responsibilities for HFE/HSE ▪ Feedback from mechanisms for HFE/ HSE issues ▪ Previous HSE audit results ▪ Human performance objectives ▪ Existing Senior Management leadership and commitment to HSE ▪ Incident, accident, and near miss data	▪ HFE Integration Vision, Mission, and Objectives ▪ HFE values and principles ▪ HFE Implementation Plan ▪ HFE Strategy	▪ Update/input into existing Company procedures for monitoring HSE performance ▪ Senior Management expectations ▪ Update/input into performance evaluation metrologies of staff ▪ Update/input into management/ employee expectations ▪ Update/input into roles, responsibilities, and accountabilities for HFE/HSE

6.3 Records

a. How Does Human Factors Relate to Records?

- Records on contractors HSE, job performance, HSE programs to check for past HFE problems and current programs
- Records on drills, including timings, persons involved, problems could reveal HFE concerns
- Records must be kept on the progress of implementation of HFE into HSE matters. Performance standards, measures, as well as the success of HFE process and the validity of criteria should be

b. What are the related Human Factors Tools/Activities for Records?		
Inputs	HF Tools and Activities	HF Outputs
▪ Existing Company documentation regarding recording keeping ▪ Previous HSE audit results ▪ Existing Company HSE policies and strategic objectives ▪ Feedback from mechanisms for HFE/ HSE issues	▪ User interviews and questionnaires ▪ Information mapping techniques ▪ Ergonomics/human factors engineering principles ▪ HFE/HSE integrated elements	▪ Update/input into existing Company documentation regarding recording keeping ▪ HFE value added to documentation accuracy and usability ▪ Update/input into documentation format and visual presentation methodologies

6.4 Non-compliance and Corrective Actions

a. How Does Human Factors Relate to Non-compliance and corrective actions?

- There must be a method / procedures for identifying non-compliances with HFE criteria, programs, policies and intent. In addition, corrective actions for identified HFE non-compliances must be recorded, tracked, implemented or it must be explained why these actions were not taken or successful.
- Follow-up should occur within a specified time period
- Documentation must be completed and kept up-to-date.

b. What are the related Human Factors Tools/Activities for Non-compliance and corrective actions?

Inputs	HF Tools and Activities	HF Outputs
▪ Previous HSE audit results ▪ Existing Company HSE policies and strategic objectives ▪ Feedback from mechanisms for HFE/ HSE issues ▪ Existing Company Quality System ▪ Previous Quality System audit results ▪ Job functions, requirements and reporting responsibilities ▪ Performance evaluations of staff ▪ Communication protocols	▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles ▪ Personnel knowledge, skills, and ability standards	▪ Update/input into existing Company Quality System ▪ Update/input into existing Company HSE policies ▪ Update/input into key performance indicators ▪ Update/input into procedures to set performance criteria

6.5 Incident Reporting

a. How Does Human Factors Relate to Incident reporting?

- Root cause analysis should include factors related to human errors and failures of management systems.
- Incidents are indications of weaknesses in management systems. As a result, all incidents must be investigated using a pre-determined assessment method. The results of the assessment should then result in changes to the management system.
- There must be criteria for specifying what encompasses an incident versus a near miss. The criteria should be documented. The incident or near miss itself should be investigated following a systematic methodology that will reveal a root cause associated with the incident. The incident investigation method should also set forth reporting requirements for incidents.

b. What are the related Human Factors Tools/Activities for Incident reporting?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing Company procedures concerning incident investigation and follow-up ▪ Incident, accident, and near miss data ▪ Existing Company HSE policies and strategic objectives ▪ Previous HSE audit results ▪ Feedback from mechanisms for HFE/ HSE issues	▪ Root cause analysis including human and organization factors ▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles ▪ Personnel knowledge, skills, and ability standards	▪ Update/input into mechanisms and responsibilities incident reporting ▪ Update/input into incident reporting procedures ▪ Update/input into incident reporting forms or checklists ▪ HFE value added to documentation accuracy and usability
6.6 Incident Follow-up		
a. How Does Human Factors Relate to Incident follow-up?		
• For every incident, the investigation should document corrective actions. The incident investigation procedure should also require monitoring of statistics to determine any trend in incidents. Time frames / limits should be set for follow-up activities. Mechanism to check if all potential human errors and management systems failures have been identified in incident report scheme.		

b. What are the related Human Factors Tools/Activities for Incident follow-up?		
Inputs	**HF Tools and Activities**	**HF Outputs**
▪ Existing Company procedures concerning incident investigation and follow-up ▪ Incident, accident, and near miss data ▪ Existing Company HSE policies and strategic objectives ▪ Previous HSE audit results ▪ Feedback from mechanisms for HFE/ HSE issues.	▪ Root cause analysis including human and organization factors ▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles ▪ Personnel knowledge, skills, and ability standards	▪ Update/input into mechanisms and responsibilities for follow-up of incidents ▪ Update/input into incident follow-up procedures ▪ Update/input into incident follow-up forms or checklists ▪ HFE value added to documentation accuracy and usability

References for HF within Implementation and Monitoring:

- AicheE (1994)
- Karwowski & Marras (Eds., 1998)
- Schwartz (Ed., 2000)
- Eastman Kodak (1983 / 1986)
- McSween (1995)
- Wilson & Corlett (1990)

Table 10. Auditing and Reviewing

7.0 Auditing and Reviewing, what is it according to the E&P Forum?
The company should maintain procedures for audits to be carried out, as a normal part of business control, in order to determine: ▪ Whether or not HSE management system elements and activities conform to planned arrangements, and are implemented effectively. ▪ The effective functioning of the HSEMS in fulfilling the company's HSE policy, objectives and performance criteria. ▪ Compliance with relevant legislative requirements. ▪ Identification of areas for improvement, leading to progressively better HSE management. For this purpose, it should maintain an audit plan, dealing with the following: ▪ Specific activities and areas to be audited. Audits should cover the operation of the HSEMS and the extent of its integration into line activities, and should specifically address the following elements of the HSEMS model: ▪ organization, resources and documentation; ▪ evaluation and risk management; ▪ planning; ▪ implementation and monitoring. ▪ Frequency of auditing specific activities/areas. Audits should be scheduled on the basis of the contribution or potential contribution of the activity concerned to HSE performance, and the results of previous audits. ▪ Responsibilities for auditing specific activities/areas.

7.1 Auditing

a. How Does Human Factors Relate to Auditing?

- HFE is applied to documents technical correction, usability, and up to date. Procedures manuals checks on root causes compared to accident and near miss reports
- Types of applicable audits HFE criteria adherence with specs, HFE's process safety occupational
- Management must require periodic audits in order to ensure that all HFE activities are taking place, that benefit is being gained from the application of HFE, that all persons in the organization understand their role with regards to HFE implementation and also to identify and gaps in implementation. Audits are also necessary to ensure that planned activities are taking place and that targets with regard to HFE are being met.
- A method for conducting audits must be predetermined and documented. The audit procedure should also identify objectives, frequency and depth of the HFE audits. The procedure should also document who is responsible for the HFE audit function as well as reporting requirements.

b. What are the related Human Factors Tools/Activities for Auditing?

Inputs	HF Tools and Activities	HF Outputs
▪ Existing HSE Auditing procedures ▪ Existing Company HSE Auditing policies ▪ Previous HSE audit results ▪ Feedback from mechanisms for HFE/ HSE issues ▪ Existing Company Quality System ▪ Previous Quality System audit results ▪ Job functions, requirements and reporting responsibilities ▪ Performance evaluations of staff	▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles ▪ Personnel knowledge, skills, and ability standards	▪ Identification of areas for improvement, leading to progressively better HSE management ▪ Update/input into audit protocols and procedures ▪ Update/input into key performance indicators ▪ Update/input into procedures to set performance criteria ▪ HFE value added to documentation accuracy and usability

7.2 Reviewing

a. How Does Human Factors Relate to Reviewing?

- Periodic review of audit findings is necessary to determine any issues that may be unresolved and also to identify trends in the audit findings. Audit results can also be reviewed together with other types of "management system" indicators, like the results of incidents and near miss investigations.
- Reviewing audit finding may point to area in the management systems that require changes or updates.

b. What are the related Human Factors Tools/Activities for Reviewing?

Inputs	HF Tools and Activities	HF Outputs
▪ Senior Management roles and responsibility ▪ Existing Company HSE policies and strategic objectives ▪ Previous HSE audit results ▪ Feedback from mechanisms for HFE/ HSE issues ▪ Existing Company Quality System ▪ Previous Quality System audit results	▪ User interviews and questionnaires ▪ Ergonomics/human factors engineering principles ▪ Personnel knowledge, skills, and ability standards	▪ Identification of areas for improvement, leading to progressively better HSE management ▪ Update/input into audit protocols and procedures ▪ Update/input into key performance indicators ▪ Update/input into procedures to set performance criteria

References for HF within Auditing and Review:

- AicheE (1994)
- Kirwan & Ainsworth (1992)
- Karwowski & Marras (Eds., 1998)
- McSween (1995)

2.1 Cost Benefit Analysis

The cost/benefit measures of HSE management systems are often incorrectly perceived as intangible. Formal management systems integrated with HF, properly designed, developed and implemented provide a foundation to measure process performance compared to criteria designed to meet end objectives. Trying to measure process performance in an informal management environment is very difficult, if not impossible, and is often characterized as "bottom line management" (i.e. "our bottom line is good, therefore our processes are performing well" or vice versa). Over time a false sense of security is formed around processes perceived by the bottom line to be performing well and various kinds of "fire fighting" are implemented for processes shown by the bottom line as not performing well. Formal management systems are used as a tool to manage and control each process, eliminate fire fighting and continuously improve performance. Management systems provide the information needed to pin point problem areas and data necessary to analyze each process such that corrective/preventive measures can be taken before they negatively impact the bottom line.

Cost benefits of integrating HF into management systems are process specific and must be measured in terms of costs saved through process improvements, such as design control, incident investigation, process controls, etc. Management systems have no cost benefit if they are not used as a tool to facilitate the management and improvement of each process. Applying formal management systems facilitates:

- Improving operating and safety conditions through the optimization and structuring of related processes.
- Establishing a common platform that can be used to evaluate and improve performance of all areas of operations (e.g. a management system that encourages sharing of strengths, correction of weaknesses and learning from mistakes).
- Improving performance and streamlining operations by analyzing performance data and making incremental refinements over time.
- Reducing risk, cost of operations, improving support services, lowering down time, fewer unplanned rework and manufacture / fabrication errors through improved control of processes and systems.
- Lowering costs associated with technological advancements, organization expansion, restructuring and change.

Hard data does exist on costs that can be saved in a variety of processes such as design control. (See the papers by Working Groups 2 and 3[1] for guidance on cost-benefits and tradeoff analysis for new, and existing, designs where this type of data has been documented.) In other processes where data has not been established, the cost/benefit relationships are not as clear.

Clearly the strongest tool available to maintain incremental improvements in operations and safety that result in significant cost and risk reduction is the use of management systems. To obtain a true picture of the overall costs and benefits a management system can provide, process improvement and related cost data must be established for all processes within an organization. When the costs of designing, developing, and effectively implementing a formal management system for all the processes are added together and compared to the cost of managing and controlling processes informally, the payback on the one-time cost for the management system is typically within four to eight months.

3.0 CONCLUDING REMARKS

Many industries, including the maritime and offshore oil and gas industries, agree that technological approaches are not sufficient to increase safety and reduce risk potential associated with hazardous operations. It is now recognized that organizations must be well managed and develop a system of HSE management which includes not only systems of work aimed at technical issues but which also include managing human and organizational factors. The management principles upon which HSE MS should be based are planning, organizing, implementing, and evaluating. It is also recognized that an effective HSE MS cannot be bought off the shelf since, as Whalley-Lloyd (1994) points out, an HSE MS has to be developed to suit a company and the people working in it. For success, an HSE MS must involve key individuals within the organization during the development of the HSE MS scheme and all individuals in the organization need to be committed to its implementation. Not only must a particular organization develop, implement, communicate, evaluate, and update its HSE MS, but that organization's management should ensure that the program contains elements similar to the guidance that is commonly accepted by its' industry and regulators.

[1] Actually WG3 doesn't say very much about CB analyses--almost only identifying the different types of costs. WG 2 does have a specific section on the subject.

This paper attempts to break new ground by incorporating the methods and principles of the discipline of human factors, as they address human performance and safety, within the elements of HSE MS. In this paper we have:

- Identified a baseline HSE MS structure and summarized its processes and phases
- Attempted to make a case for HF in the context of HSE MS
- Identified the potential interactions and contributions of HF within the HSE MS framework
- Generated a table containing detailed guidance to conduct and assess the managed integration of HF in the HSE MS framework.
- Suggested a cost-benefits analysis is useful to assess the viability, robustness, and costs associated with integrated processes

It must be noted that the integration presented in this paper is notional, and is in no way validated or proved, nor is it recommended for immediate use by HSE MS personnel that may be interested in such a union between HSE MS and HF. The objective of this paper was to initiate discussion and dialog on the potential for such integration. This we believe was accomplished during the 2002 Workshop for this topic.

We recommend that integration of these disciplines continue to be developed and analyzed, and implemented in discrete elements to help quantify and qualify any benefits and costs that may be accrued. Ultimately, this paper represents an early step on the path to an integrated HSE MS and HF process.

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