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Development of Guidelines for Assessment of Drillfloor Human Factors Issues

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Development of Guidelines for Assessment of Drillfloor Human Factors Issues

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EXECUTIVE SUMMARY

The safety design and layout of drillfloors and Driller's cabins is not currently prescribed in any industry code or standard and it is perceived that the incorporation of Human Factors into the drillfloor design process is still a weak area. Because of the diverse range and age of drillfloor designs currently in use, the differing degrees of mechanisation and automation they present and the lack of available design guidance on safety, then currently an Inspector can only carry out an assessment of safety by applying first principles. This is time-consuming and it does not prevent inconsistencies from arising due to the different approaches and expertise of individual Inspectors.

In order to help alleviate this problem, WS Atkins (WSA) was contracted by the UK Health & Safety Executive (HSE) to develop practical guidelines to aid Inspectors with their inspections and assessments of offshore installations. The aim of the guidelines was to provide a specific focus on the Human Factors issues which are a major influence on the occurrence of occupational injuries to Drill Crew personnel. The guidelines have been developed in the form of a Drillfloor Human Factors (HF) Assessment Template.

This report describes the approach that was taken by WS Atkins in the development of the Drillfloor HF Assessment Template. The following conclusions are noted with respect to the optimal use of the Template:

- The HF Assessment Template should be updated on a regular basis. Feedback forms should be provided in the HF Assessment Template package to enable Inspectors to provide comments on aspects of the guidelines that require revision. These forms should be collated and used to inform the regular revisions. In addition, it is advised that Inspectors should be asked to identify where modifications or further guidance would improve the assessment process.

- The format and presentation of the HF Assessment Template should be tailored and finalised with the co-operation of offshore Inspectors in order to ensure maximum usability and robustness in the offshore environment.

- The vast majority of incident reports reviewed by WS Atkins during the production of the HF Assessment Template only reported on the immediate circumstances of the incident and provided superficial consequence categorisation associated with injuries / damage incurred. If more in-depth analysis of incidents is required, then further work would be necessary to ensure that incident and near miss reporting is adequate to capture all the relevant information associated with the root causes and contributory factors of offshore incidents.

Finally, it is noted that the focus of this work is on Human Factors and the guidelines do not cover the system safety issues associated with drillfloor equipment.

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1. INTRODUCTION

1.1 Background

Drillfloor operations have traditionally required a significant amount of physical labour from Drill Crews working within a restricted area, often in difficult environmental conditions. The evidence from accident statistics and formal risk assessments is that occupational hazards represent a significant proportion of the overall risk to drill crew personnel.

The design and layout of the drillfloor on offshore installations has been continually evolving to reflect the introduction of more mechanised and automated control systems. Increasingly, equipment that has traditionally been manually operated by the Drill Crew is now operated remotely from the Driller's cabin. The Driller's functional role is therefore increasing in scope at the same time that new and relatively unfamiliar systems are being introduced. Increasing reliance on drillfloor automation also appears to be changing the risk profiles for activities undertaken by Drill Crew personnel.

The safety design and layout of drillfloors and Driller's cabins is not currently prescribed in any industry code or standard. Designs for new builds and upgrades of drillfloors and cabins are often driven by the introduction of new equipment from manufacturers. It is perceived that the incorporation of Human Factors into the drillfloor design process is still a weak area.

Because of the diverse range and age of drillfloor designs currently in use, the differing degrees of mechanisation and automation they present and the lack of available design guidance on safety, then currently an Inspector can only carry out an assessment of health and safety by applying first principles. This is time-consuming and does not prevent inconsistencies from arising due to the different approaches and expertise of particular Inspectors.

In order to help alleviate this problem, WS Atkins Safety & Reliability (WSA) was contracted by the UK Health & Safety Executive (HSE) to develop practical guidelines to aid Inspectors with their inspections and assessments of offshore installations. The aim of the guidelines was to provide a specific focus on the Human Factors issues which are a major influence on the occurrence of occupational injuries to Drill Crew personnel. The guidelines have been developed in the form of a Drillfloor Human Factors (HF) Assessment Template.

This report describes the approach that was taken by WS Atkins in the development of the HF Assessment Template.

1.2 Objectives

The objective of the current research was to develop practical guidelines for Inspectors when assessing Human Factors issues on drillfloors. The aim was to provide guidelines in a form that would:

- Act as an *aide memoir* for Inspectors when performing assessments of offshore installations;
- Provide Inspectors with a structured approach to data collection and documentation of the Assessment process;
- Enable non-specialist Inspectors to perform drillfloor assessments.

The specific objectives for the content of the guidelines were that they should facilitate the systematic assessment of Human Factors issues related to the design of the drillfloor and the safety of drillfloor activities and operations.

It was agreed that the most likely format for presenting the guidelines would be as an Assessment Template.

1.3 Scope of Work

The scope of the work was defined as follows:

1. To develop assessment guidelines in the form of a Template;
2. To develop accompanying documentation to guide Inspectors in using the Assessment Template;
3. To test the Assessment Template by application to an offshore installation
4. To produce a report summarising the work undertaken.

The approach taken in the development and testing of the Assessment Template is described in this report, which constitutes the output from step 4 above.

2. APPROACH

The following activities were undertaken in the development and testing of the Template:

1. Familiarisation with drillfloor equipment and activities
2. High-level Task Analysis of drillfloor operations
3. Identification of drillfloor hazards and key Human Factors issues impacting on safety
4. Development of Template Structure and production of prototype
5. Template review and testing
6. Production of finished Template

Each of these activities is discussed in detail below.

2.1 Familiarisation With Drillfloor Equipment & Activities

2.1.1 Review of Documentation

WSA Human Factors staff reviewed training and research publications on offshore drilling and production technology in order to gain an appreciation of the activities involved in drilling operations, and the range of technology that is used.

2.1.2 Observation of drillfloor layout and operations at two on-shore rigs.

A visit was undertaken by two WSA analysts to an on-shore drilling facility in order to undertake a first-hand assessment of Human Factors issues relating to drillfloor layout and equipment. Observations were undertaken at two drillfloors: a large semi-automatic rig and a small manually-operated rig. At the small rig, roughnecks were observed making up and spinning in the drillpipe.

2.2 High-level Task Analyses of Drillfloor Operations

The information obtained from the site visit, along with the data on drillfloor activities obtained from the literature review, was used as a basis for the development of Task Analyses to describe drillfloor operations.

Because of the amount of variation in drillfloor equipment that exists across offshore installations, it is difficult to construct a single definitive detailed Task Analysis of all drillfloor activities. Rather than a comprehensive and detailed analysis, the objective of the Task Analysis phase was to identify the generic activities undertaken by Drill Crew personnel as a basis for the identification of potential hazards and relevant Performance Influencing Factors (PIFs).

The output of a Task Analysis on 'Running in the Hole" and 'Tripping' operations is shown in Appendix 1 as Table A-1. This analysis was mainly based upon the information contained in the book "An Introduction to Marine Drilling", and is considered to be representative of manual drilling operations using a kelly and rotary table system.

The review of documentation supplied by HSE revealed that a considerable amount of research has already been undertaken into Human Factors and ergonomics aspects of drillfloor safety and doghouse design. Of particular use to the current study was the fact that Hierarchical Task Analyses (HTAs) of drillfloor tripping operations have previously been undertaken by Birmingham University (Basra, Gibson & Kirwan, 1996).

Table A-2 in Appendix 1 provides a tabular representation of the HTAs undertaken by Basra et al, and contained in the report *Collection of Offshore Human Error Probability Data, Phase 2, Volume 1: Offshore Drilling Data. August 1997.* It is stated in this report that the HTAs were constructed by consulting general references, and were subsequently modified by undertaking a visit to an onshore rig and observing a number of operations; finally, discussions were held with personnel at the onshore rig to finalise the HTAs. The operations described in Table A-2 are representative of rigs with a higher degree of mechanisation in relation to the operations described in Table A-1. Table A-2 describes the use of an Iron Roughneck and Top Drive system.

2.3 Identification of Drillfloor Hazards & Key Human Factors Issues Impacting on Safety

2.3.1 Review of Previously Published Research

WSA were supplied by HSE with a number of previously published research documents relating to drillfloor safety and the Human Factors aspects of drillfloor design. These documents were used as the starting point for the identification of drillfloor hazards and Performance Influencing Factors (PIFs).

In addition, a further search of published research on drillfloor safety in relation to ergonomics was also carried out. A full list of the documents that were reviewed by WSA is contained in the References section of this report.

2.3.1.1 Four Elements Report

As a starting point for the current project, WSA reviewed the report "Drillfloor Design - A Consideration of Human Factors" (OTH 94 443) which was produced by Four Elements on behalf of the HSE. While the report was found to identify some of the key Human Factors areas affecting drillfloor safety, it does not establish any link between drillfloor accidents and specific Human Factors parameters, nor does it establish any link between drillfloor accidents and specific drilling equipment or activities. The data analysis was not considered to be specific enough to aid in the identification of key risk contributors.

2.3.1.2 Rogaland Research Report

The Rogaland Research report for HSE entitled "Key Issues On How Rig Automation Will Affect Human Safety" (RF 191/93) was reviewed by WSA. This report assesses the data on drillfloor-related accidents before and after rig automation. It reports that there has been a significant improvement in overall accident rates for Drill Crews on rigs following automation, but this has been accompanied by an increase in accident rates among maintenance workers. The conclusion of the report, which is supported by studies into the impact of automation in other industries, is that fewer manual handling accidents are balanced by more repair and maintenance accidents. This report was found to contain much data relating drillfloor accidents to specific activities, worker categories and equipment.

2.3.2 Review of Incident Data

It was outside the scope of the current study to undertake a statistical evaluation of offshore accident statistics. However, a brief high-level review of Lost Time Incident (LTI) data was carried out in order to provide WS Atkins with an understanding of the main causes of occupational injuries to Drill Crew personnel. The following sources of information were used:

1. Incident data for 1991 to 1996 taken from the HSE Offshore Safety Division's OIR 9A safety database.
2. International Association of Drilling Contractors (IADC) data on LTIs during 1996.

2.3.2.1 OIR 9A Database

The OIR 9A database search revealed that from 1991 to 1996 the six most common types of drilling-related incidents that have been reported (from a total of 1050 incidents) are as follows:

1. Falling objects	183 incidents
2. Lifting or crane operators	147 incidents
3. Slips, trips or falls	137 incidents
4. Use of machinery	123 incidents
5. Handling materials	121 incidents
6. Use of hand tools	40 incidents

Provisional data on offshore injuries for April 1996 to March 1997 provided by the HSE (source: internet @ www.ukooa.co.uk) shows *slips, trips and falls* to be by far the main cause of over 3-day injuries offshore, and the main cause of major injuries. The second most frequent cause of over 3-day injuries is *handling goods/materials*, followed by *falling objects*, *use of machinery*, and *use of hand tools*. This data, which relates to all offshore operations, is generally supportive of the key causes of drilling operations incidents as detailed above.

A review of the brief textual descriptions of incidents from 1991 to 1996 from the OIR9A database confirmed that the main types of incidents to Drill Crew personnel are as follows:

- **Falling from height**, because of slipping, failure to adher to correct working procedures, or structural collapse;
- **Struck by drillpipe** or other moving objects, because of unexpected movement (e.g. movement of rig, wind) or failure to observe correct procedures;
- **Struck by detached object** following failure of equipment (including elevators, hoses, wires, etc.) due to wear (e.g. shearing) or incorrect connection;
- **Crushed between two objects** or against a piece of equipment (e.g. feet trapped between casing or tubulars caused by slipping off walkway);
- **Struck by falling object** because of failure of equipment (e.g. elevators) due to wear or incorrect connection, or because of operator error (e.g. Derrickman dropping object);
- **Slipping or tripping on deck.**

A closer examination of the data relating to 540 of the incidents revealed the causes of injury and the most frequently injured parts of the body to be as follows:

Causes of injury		Most frequently injured parts of the body	
1. Break / fracture	26%	1. Fingers	23.5%
2. Bruise	19%	2. Hand	12%
3. Crush	17%	3. Back	12%
4. Sprain / strain	15.5%	4. Foot	11%
5. Cuts	7%	5. Leg	9%
6. Amputation	6%	6. Arm	6.5%
		7. Head	6%

2.3.2.2 1996 IADC Data

The 1996 IADC data for European waters relates only to incidents reported by drilling contractors. The IADC data supported that contained in the OIR 9A database, with the most injuries being caused to the fingers, followed by the back and then the feet / ankles. 39.6% of all LTI incidents occurred on the rig floor, with 3.6% on the Derrick. A summary of the other key findings from the IADC data is presented below.

The data provides a useful guide to the type of incidents that occur, but is less informative with respect to the underlying causes of drillfloor incidents. WS Atkins have made initial approaches to the IADC with a view to discussing ways in which the collection and analysis of incident data can be optimised to provide valuable information on root causes. It is hoped that further research may result from these discussions.

LTIs by operation	**LTIs by equipment**
1. Tripping in / out 2. Rig repairs / maintenance 3. Routine drilling operations 4. Walking 5. Material handing 6. Laying down / picking up	1. Pipes / collars / tubulars 2. Stairs / ladders / decks 3. Tongs
LTIs by accident type	**LTIs by occupation**
1. Caught between / in 2. Struck by 3. Slip / fall: different level 4= Strain / overexertion 4= Slip / fall: same level	1. Floorman (= Roughneck) 2. Roustabout 3. Derrickman 4. Driller

2.3.2.3 Conclusions

The brief review of the statistical incident data that was undertaken by WS Atkins provided confirmation that the majority of injuries associated with drillfloor operations are caused to roughnecks / floormen and generally arise because of the inherently difficult and hazardous nature of the work being carried out. For example, the drillfloor may be slippery and wet and gusts of wind may cause suspended equipment to move unexpectedly.

In the absence of a detailed analysis of the root causes of drillfloor accidents and near misses, it was not possible to categorically identify the underlying causes of the various types of incident. However, from this high-level review of the data the apparent 'front end' causes of the main types of incident can be summarised as follows:

- The majority of incidents would seem to be associated with a failure of personnel to take sufficient care in planning and executing their tasks, given the hazardous nature of the operations and equipment being used. Because of the high percentage of operations concerned with physical manipulation of heavy tools and materials, the likelihood of limbs being crushed or hit by unexpected movements is high unless good working practices are stringently adhered to.

- The failure of equipment, such as rupturing hoses or wires springing free, appears to be another key cause of injury, and may be related in some cases to inadequate maintenance or a failure to operate equipment within prescribed limits. Similarly, a number of the incidents of falling objects or personnel that are due to collapse of the rig structure or failure of particular pieces of equipment may be due to inadequate maintenance or checking procedures.

In relation to the quality of incident reports reviewed, it is considered that the vast majority of incident reports only report on the immediate circumstances of the incident and provide superficial consequence categorisation associated with injuries / damage incurred.

2.3.3 Identification of Key Human Factors Issues

The reviews of previous research and HSE / IADC incident data that were undertaken enabled WS Atkins to identify the key Human Factors issues relating to drillfloor operations that should form the focus of the Drillfloor HF Assessment Template.

Column 1 of the following table shows the main Human Factors areas that were identified for inclusion in the scope of the HF Assessment Template. Column 2 shows the likely beneficial impact of improvements in these areas with respect to drillfloor incidents and accidents.

Human Factors Issue for potential improvement	Likely Beneficial Impact on Safety
The design of the Driller's Cabin and console Including consideration of: • positioning, ease of use and suitability of controls and displays • line of sight requirements to the drillfloor, derrick, etc. • Cabin space requirements and traffic flow • environmental issues (lighting, noise)	• Reduced likelihood of occupational injuries to Driller / Assistant Driller caused by poor posture, stretching, inadequate space. • Reduced likelihood of Drill Crew personnel being injured by unexpected drill stand / drill pipe movements (due to Driller's poor view of drillfloor).
The design and maintenance of drillfloor equipment. Including consideration of: • suitability of equipment for operations, and ease of maintenance • accessibility of equipment manuals • adequacy of management system and facilities for inspection, maintenance and repair	• Reduced likelihood of occupational injuries, cuts and bruises, to personnel involving in manual drillfloor operations. • Reduced likelihood of equipment failure leading to injury of personnel.
Adherence to safe working practices during manual handling operations at the drillfloor	• Reduced likelihood of occupational injuries, cuts and bruises, to personnel involving in manual drillfloor operations.
Environmental aspects of drillfloor operations Including consideration of: • illumination level, noise • cleanliness of the drillfloor, storage of equipment, trip hazards • use of warning signs • sufficient working space for manual operations (e.g. spinning up)	• Reduction in the number of slips, trips and falls among Drill Crew personnel. • Reduced likelihood of occupational injuries, cuts and bruises, to personnel involving in manual drillfloor operations. • Reduced likelihood of Drill Crew personnel being injured by movement of drill pipe or other equipment.

Human Factors Issue for potential improvement	Likely Beneficial Impact on Safety
Job planning and use of written procedures Including consideration of: • high-level planning for drilling operations • planning for unusual events • pre-planning for specific operations • accessibility and adequacy of procedures • shift changeover procedures • formal communication arrangements	• Reduced likelihood of injuries to Drill Crew personnel arising because of inappropriate use of equipment. • Reduced likelihood of injuries to Drill Crew personnel arising because of unidentified, and therefore uncontrolled, hazards. • Reduced likelihood of injuries to Drill Crew personnel arising because of a failure to follow procedures correctly.
Adequacy of training Including consideration of: • initial and refresher training • dissemination of safe working practices • assessing competency • correct use of PPE	• Reduced likelihood of injuries to Drill Crew personnel arising because of a failure to follow procedures correctly. • Constant reduction in likelihood of injuries to Drill Crew personnel due to increased adoption of safer working practices.
Communications Including consideration of: • communications within the Drill Crew (e.g. communicating drill stand movements) • communications between Drill Crew and other rig personnel • communications between Drill Crew and management / supervisory staff	• Reduced likelihood of Drill Crew personnel being injured by unexpected movement of drill pipe or other equipment. • Reduced likelihood of injuries to non-Drill Crew personnel arising from drilling operations.
Job design and supervisory arrangements Including consideration of: • manning level • cognitive and physical workload • ensuring use of safe working practices	• Reduced likelihood of accidents occurring because of physical fatigue among personnel on the drillfloor. • Reduced likelihood of errors occurring because of cognitive fatigue on behalf of the Driller.

The incorporation of the key Human Factors issues identified above into the structure of the Drillfloor HF Assessment Template is described below in Section 2.4.

2.4 Development of Template Structure & Production of Prototype

It was decided that the structure of the Drillfloor HF Assessment Template should comprise the following basic elements:

- Instructions on how to use the Template during an assessment
- A means of recording details of the rig undergoing the assessment
- A 'checklist' section to systematically guide Inspectors in looking at all relevant Human Factors issues
- A means of scoring the assessment to facilitate presentation of results to the rig owner
- Background information on drillfloor equipment and operations
- Guidance on Human Factors issues relating to drillfloor safety.

The original remit for the study was that it should be focused on the physical ergonomics aspects of the drillfloor and Driller's cabin. However, investigation of the nature of drillfloor incidents (see Section 2.3) revealed that the identification and assessment of physical aspects of the drillfloor would only address *some* of the relevant safety issues. For example, while it is important to ensure adequate sightlines from the Driller's cabin to the drillfloor, there is likely to be a limit to the number of incidents which could be prevented and/or injuries which could be reduced by changing physical aspects of the drillfloor layout.

It was therefore recognised that in order to offer a truly comprehensive evaluation of drillfloor hazards, either the scope of the guidelines had to be expanded, or the Template had to be used as one part of a more wide-ranging assessment of the management systems governing drilling operations. However, for the prototype Assessment Template the emphasis on collection of assessment data through observation of drilling activities and equipment was retained.

A list of detailed prompts to guide Inspectors in assessing a wide range of Human Factors issues was produced.. One of the key decisions required for the finalisation of the HF Assessment Template structure was to determine how specific Human Factors issues could be best organised to facilitate the assessment. Consideration was given to structuring the assessment according to particular drilling operations (e.g. tripping), or particular items of equipment (e.g. use of the Iron Roughneck). The decision taken for the production of the prototype version of the HF Assessment Template was to organise prompts according to operator, i.e. either the Driller's equipment and activities or the equipment used and activities undertaken by Roughnecks on the drillfloor itself. Under *Driller Operations* or *Roughneck Operations*, individual question prompts were organised under the following categories:

Roughneck Operations:
- Equipment
- Lifting and Carrying Activities
- Environmental Issues
- Communications
- Working Arrangements & Procedures

Driller Operations:
- Communications / Sightlines
- Cabin Layout & Design
- Job Design & Working Arrangements

2.5 Template Review and Testing

A first draft of the Assessment Template was presented to a group of five HSE Inspectors by WSA on 29 April 1998. Initial perceptions of the format of the Template were good. Minor revisions to the Template format were made to reflect the comments that were received.

The revised draft of the prototype Template was tested during a visit to the Ensco 80 installation on 11 June 1998. A WSA analyst accompanied two HSE Inspectors (one a Well Operations Inspector, the other a General Safety Inspector) who undertook a sample assessment using the Template. The following information was collected by the WSA analyst, with respect to the perceptions of the Inspectors testing the Template:

- Ease of use;
- Comprehensiveness;
- Format;
- Terminology used;
- Significant omissions.

Both Inspectors provided detailed comments on the format and content of the Template. The key revisions made as a result of this exercise were as follows:

- For the 'checklist' of question prompts, the Inspectors expressed a preference for certain issues that are relevant to both Driller and Roughneck operations (e.g. Communications) to be re-organised as distinct categories. The overall number of categories of Human Factors issues, and the content of those categories, was changed according to the specific requests received.

- It was noted that Inspectors could only assess particular drilling activities if they were being undertaken at the time of the inspection. It was therefore requested that the Template should place more emphasis on reviewing working procedures and talking to personnel about the problems faced in carrying out particular operations. Guidance was therefore incorporated within the Template to act as an *aide memoir* for Inspectors to evaluate the planning, procedures and supervisory systems in place to safely manage drillfloor operations.

- Additional information was incorporated in the question 'prompts' to guide Inspectors as to the most likely source of information for completion of the assessment; e.g. observation, discussion with personnel, or documentation review. An additional column was provided in the 'checklist' tables to enable Inspectors to document the source of information used as the basis for their assessment.

- Inspectors stated that they could not be expected to determine whether or not particular items of drilling equipment were in a state of poor repair. For issues of this type, the emphasis of the guidance was changed to recommend reviews of the management systems governing inspection and maintenance procedures.

- The scoring system used for the assessment was changed from a five-point to a six-point scale in order to remove the mid-point option.

2.6 Production of Finalised Assessment Template

The format of the finalised HF Assessment Template is designed to guide Inspectors systematically through the collection of data relating to the operations carried out by Roughnecks and Drill Crew on the drillfloor, and the operations undertaken by the Driller (and Assistant Driller, if appropriate) within the Driller's cabin.

The Template is split into five distinct sections, the contents of which are as follows:

Section A	**Instructions for Use**
A-1 Introduction	Basic introduction to the Template structure.
A-2 Data Collection	Guidance on data collection for completion of the assessment.
A-2 How to Complete the Template	Instructions on completion of the assessment checklist and scoring of the assessment findings.

Section B	**Assessment Record**
B-1 Record of Observation	Proforma for recording details of rig, operator/owner, contractors, activities observed, documentation reviewed and staff interviewed.
B-2 Level of Automation	Proforma for recording details of level of automation on the rig.

Section C	**Observation / Questionnaire Checklist**
C-1 Contents	List of tables contained in this section.
C-2 Checklist	This section forms the main part of the HF Assessment Template. It contains seven tables, each representing a key category of Human Factors issues. Each table contains detailed prompts enabling the Inspector to systematically assess a wide range of Human Factors issues relating to Drill Floor operations.

Section D	**Summary of Assessment Results**
D-1 Scoring the Assessment	Instructions on scoring of the assessment and identification of actions.
D-2 Summary Sheet	Proforma for recording details of assessment scores and key problems identified under each Human Factors category.
D-3 Action Sheet	Proforma for recording actions to be taken arising from the assessment.
D-4 Sample Recommendations	Examples of recommendations for actions, provided as a prompt to the Inspector.

Section E	**Guidance And Supporting Information**
E-1 Human Factors Guidance	Background to main Human Factors issues relating to Driller's Console and Driller operations, and Drill Floor equipment and operations.
E-2 Common Manual Operations and Equipment	Background to common drillfloor operations involving physical manipulation of equipment.
E-3 Glossary of Drilling Terms	Glossary of key terms for drilling operations and equipment.

Sections B and C constitute the 'checklist' of prompts to be used by the Inspector during the actual assessment process at the drillfloor. Section D contains proformas that can be used by the Inspector to provide a summary of the results of the assessment to the rig owner. Sections A and E of the Template provide the Inspector with details on how to use the Template and essential background on drilling equipment and operations.

The 'checklists' contained in the Template will guide the Inspector through the systematic assessment of the following Human Factors issues:

Human Factors Categories	**Number of Specific Issues Addressed**
Driller's Cabin: Layout and Design	17
Drillfloor:	
– Equipment	6
– Lifting and Carrying Activities	5
– Environmental Issues	7
Communications	5
Job Planning, Written Procedures and Training	8
Job Design and Working Practices	4

For each of the 52 specific Human Factors issues addressed in the checklists, the Inspector is asked to evaluate 'adequacy' with respect to the installation using a six-point scale. Detailed 'question prompts' are provided to help the Inspector in this evaluation process. For each of the seven main categories of Human Factors Issues, individual adequacy scores are summed to give an overall Sub-Total Score.

The Sub-Total Score provides a simple means of identifying where particular problems may be manifest, while the adequacy scores for the individual Human Factors issues enable specific failings to be identified. In both cases, a low score indicates a potential problem. The checklists also provide space for the Inspector to note any key problems that are identified during the assessment.

The Template's scoring system can be used to provide a simple illustration of the main assessment findings to the rig owner, and may also be used as a means of prioritising and planning remedial actions.

The Template provides a Summary Sheet on which the key problems identified under each of the seven main categories of Human Factors issues can be detailed. Similarly, actions identified as arising from the assessment can be summarised on the Action Sheet provided. Both proformas are designed to be presented to the rig owner as a record of the assessment results.

The final version of the Template has been presented to the HSE in hardcopy report and electronic copy formats. The following recommendations are made regarding some practical issues of actually using the Template on the drilling rig:

- The HF Assessment Template should be housed in a robust A4 or A5 size folder.
- The whole of Sections A and E, and pages D-1 and D-4 should be laminated, as these contain the instructions and guidance sections of the Template.
- Forms D-2 and D-3 are intended to be copied to the rig owner at the completion of the assessment. A number of photocopies of these forms should therefore be kept within the folder.
- Sections B and C should be detachable from the body of the HF Assessment Template so that they can be used by the Inspector on the rig floor. These sections should be produced in A5 size to make them easier to carry. They should ideally be produced in a robust separately bound format. A number of copies of these bound sections should be kept within the folder, together with spare copies of individual pages.

3. CONCLUSIONS & FURTHER REQUIREMENTS

1. The guidance within the Drillfloor HF Assessment Template is principally focused on drillfloor operations using manually operated equipment. However, drilling operations are increasingly mechanised and drilling equipment may vary from rig to rig according to the requirements of the rig owner and the particular equipment supplier used. It is recognised that the Template as it stands cannot expect to be comprehensive with respect to coverage of all drilling equipment and operations.

   It is therefore recommended that the HF Assessment Template be updated on a regular basis. Feedback forms should be provided in the Template package to enable Inspectors to provide comments on aspects of the guidelines that require revision. These forms should be collated and used to inform the revisions. In addition, Inspectors should be asked to identify where modifications or further guidance would improve the assessment process. A sample feedback form is attached as Appendix 2.

2. The format and presentation of the Template should be tailored and finalised with the co-operation of Inspectors in order to ensure maximum usability and robustness in the offshore environment. Issues that need to be resolved will include:

   - Size and format
   - Design and manufacture of Template
   - Use of colour

3. WS Atkins were not able to find (within the HSE and IADC data) any detailed analyses of the root causes of offshore drilling accidents and near misses. The focus of the Template is therefore based largely upon the expertise of WS Atkins' Human Factors staff and their knowledge of human error and the primary factors impacting on safe performance. Recent HSE studies agree with the focus applied. This expertise has been coupled with the assessment of drillfloor workplace factors undertaken during site inspections.

   If more in-depth analysis of incidents is required, then further work would need to be undertaken to ensure that incident and near miss reporting is adequate to capture all the relevant information associated with the root causes and contributory factors of offshore incidents. This is strongly recommended, since the vast majority of incident reports reviewed only described the immediate circumstances of the incident and provided superficial consequence categorisation associated with injuries / damage incurred. However, the current regulations (RIDDOR) do not facilitate this recommendation.

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APPENDIX

DRILLFLOOR TASK ANALYSIS TABLES

Table A-1 Hierarchical Task Analysis of Tripping Operations (adapted from Basra et al 1996)

Superordinate	Task Component - operation or plan
TRIPPING OUT	**TRIPPING OUT ONE STAND** Plan: 1-3 only for first stand; 4 and 5 in order until all stands are tripped. 1. Stop drilling 2. Prepare hole to trip out 3. Lift first stand with top drive 4. Prepare to lift stand 5. Lift stand
2.	PREPARE HOLE TO TRIP OUT Plan: in order. 2.1 Circulate mud to clean hole 2.2 Review condition of well 2.3 Do flow check 2.4 Line up trip tank
3.	LIFT FIRST STAND WITH TOP DRIVE Plan: in order. 3.1 Start trip tank 3.2 Attach top drive to first stand 3.3 Lift stand 90ft 3.4 Set slips 3.5 Break off top drive 3.6 Use iron roughneck to break joint 3.7 Set stand back
4	PREPARE TO LIFT STAND Plan: in order. 4.1 Lower elevator 4.2 Latch elevator to stand
5	LIFT STAND Plan: 1 and 2 in order; 3 and 4 simultaneously; 5; 6 only after every 5 stands tripped; 7 and 8 in order. 5.1 Pick up stand to take weight 5.2 Release slips 5.3 Pull stand up 90ft 5.4 Monitor stand weight 5.5 Set slips 5.6 Take trip tank measurements 5.7 Use iron roughneck to break joint 5.8 Set stand back
3.6	USE IRON ROUGHNECK TO BREAK JOINT Plan: in order. 3.6.1 Break seal 3.6.2 Rapid spin out

Superordinate	Task Component - operation or plan
3.7	SET STAND BACK <u>Plan: in order.</u> 3.7.1 Throw rope round top of stand 3.7.2 Lift stand up slightly 3.7.3 Move bottom of stand into position 3.7.4 Position top of stand 3.7.5 Release elevators
5.7	USE IRON ROUGHNECK TO BREAK JOINT <u>Plan: in order.</u> 5.7.1 Break seal 5.7.2 Rapid spin out
5.8	SET STAND BACK <u>Plan: in order.</u> 5.8.1 Throw rope round top of stand 5.8.2 Lift stand up slightly 5.8.3 Move bottom of stand into position 5.8.4 Release elevators 5.8.5 Position top of stand
TRIPPING IN	**TRIP IN ONE STAND** <u>Plan: in order.</u> 1. Pick up elevator 90ft 2. Prepare to move stand from rack 3. Position stand 4. Use iron roughneck to connect joint 5. Lower stand into hole 6. Set slips 7. Release elevator
2	PREPARE TO MOVE STAND FROM RACK <u>Plan: in order.</u> 2.1 Attach guiding rope to bottom of stand 2.2 Throw rope round top of stand 2.3 Latch elevator to top of stand
3	POSITION STAND <u>Plan: in order.</u> 3.1 Pick up stand slightly 3.2 Restrain / guide bottom of stand into position
4	USE IRON ROUGHNECK TO CONNECT JOINT <u>Plan: in order.</u> 4.1 Rapid spin in. 4.2 Secure joint to torque.

Superordinate	Task Component - operation or plan
5	LOWER STAND INTO HOLE Plan: in order. 5.1 Pick up stand to take weight. 5.2 Release slips.

Table A-2 Hierarchical Task Analysis of Drill Floor Operations
(Based upon information contained in "An Introduction to Marine Drilling")

Superordinate	Task Component - operation or plan
RUNNING IN THE HOLE	RUNNING IN THE HOLE <u>Plan: do 1 to 4 in order.</u> 1. Make up Bottom Hole Assembly (BHA) 2. Connect stands of drill pipe to BHA 3. Remove kelly 4. Commence 'drilling ahead'
1.	MAKE UP BOTTOM HOLE ASSEMBLY (BHA) <u>Plan: do 1.1 to 1.5 in order.</u> 1.1 Pass BHA item by item through rotary table opening. 1.2 Paste components in turn with thread compound 1.3 Screw components together ('make up') 1.4 Lower components through rotary using elevators 1.5 As each item is lowered through rotary, apply drawworks brake and insert slips
2.	CONNECT STANDS OF DRILL PIPE TO BHA <u>Plan: do 2.1 to 2.14 in order.</u> 2.1 Fit elevators round the shoulders of the upper tool joint of the stand to be lowered. 2.2 Release stand from fingerboard. 2.3 Guide lower end of stand over rotary 2.4 Stab stand into the tool joint box of the tubular (held in the slips). 2.5 Spin up connection. 2.6 Apply correct torque to the connection using tongs. 2.7 Secure break-out tong round the lower of the two tool joints. 2.8 Apply make-up tong to the top joint 2.9 Tighten connection to the correct torque. 2.10 Remove slips 2.11 Lower stand into rotary. 2.12 Apply drawworks brake. 2.13 Insert slips between rotary bowl and pipe to grip it 2.14 Release elevators to pick up the next stand.
3.	REMOVE KELLY <u>Plan: do 3.1 to 3.3 in order when last stand of pipe is in the slips.</u> 3.1 Remove kelly from rat hole. 3.2 Screw kelly into drill pipe. 3.3 Torque-up using tongs.
4.	COMMENCE 'DRILLING AHEAD' <u>Plan: do 4.1 to 4.6 in order</u> 4.1 Start mud pumps 4.2 Lower kelly until kelly bushing engages with rotary master bushing. 4.3 Announce 'returns at the shaker' 4.4 Start rotary turning 4.5 Ease off drawworks brake to lower bit to bottom of hole. 4.6 'Drilling Ahead' commences when bit touches bottom.

Superordinate	Task Component - operation or plan
TRIPPING	TRIPPING Plan: do 1, then do 2 - 4 in order for each stand of pipe, then do 5. 1. Remove Kelly 2. Break connection 3. Lift stand 4. Set back stand 5. Remove drill bit
1.	REMOVE KELLY Plan: in order 1.1 Pull up kelly 1.2 Insert slips around drill pipe in the rotary bowl 1.3 Loosen and break connection between drill pipe and the kelly 1.4 Lift kelly into rat hole
2.	BREAK CONNECTION Plan: in order 2.2 Use break-out tong to loosen connection by applying it to the top tool joint 2.3 Break connection and spin loose
3.	LIFT STAND Plan: in order 3.1 Lower pipe elevators and attach to the shoulders of protruding tool joint 3.2 Hoist stand of pipe out of the hole until tool joint of next stand is in correct position for unscrewing. 3.3 Insert slips
4.	SET BACK STAND Plan: in order 4.1 Guide top of stand of pipe into slot in fingerboard 4.2 Guide lower end of stand towards set-back area. 4.3 Set down stand 4.4 Unlatch pipe from elevator
5.	REMOVE DRILL BIT Plan: in order 5.1 Lift bit clear and place bit breaker in the rotary 5.2 Insert bit into bit breaker 5.3 Apply break-out tongs to loosen connection with collar 5.4 Unscrew bit by hand and lift off drill collar 5.5 Remove bit from breaker and examine for wear