Manual handling incidents database

A *compilation and analysis of offshore industry reports*

Prepared by **Hu-Tech Ergonomics**
for the Health and Safety Executive 2006

RESEARCH REPORT 500

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Information from offshore manual handling incident reports have been analysed to establish the underlying factors and trends as well as the more obvious 'end point' causes. The objective was to identify case study material aimed at preventing manual handling injuries.

Forty case studies are presented that show the root causes of manual handling incidents offshore. Identifying the root cause provides the basis for finding solutions that will minimise the likelihood of the incident happening again. Analysis of a total sample of 126 recent manual handling incidents from the offshore industry indicated a variety of root causes, the majority existing at a system level (that is, at a management and planning level). The most commonly found root causes were poor workplace design, poor equipment design and the use of inappropriate equipment. Inadequate risk assessment was found to be a root cause in 5% of incidents, indicating not so much that risk assessments are generally done to an acceptable level, but that a sub-standard risk assessment was not a fundamental source of risk in many incidents. The inadequate risk assessment represents an opportunity missed to identify significant risks.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

HSE BOOKS

ACKNOWLEDGEMENTS

The authors wish to extend their thanks to the following organisations that have provided material for the manual handling incidents reported here.

- BP Exploration Operating Company Ltd
- Maersk Contractors
- Salamis Group
- Shell UK Ltd
- Step Change in Safety
- Health and Safety Executive Offshore Safety Division

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EXECUTIVE SUMMARY

Forty case studies are presented that show the root causes of manual handling incidents offshore. Identifying the root cause provides the basis for finding solutions that will minimise the likelihood of the incident happening again. In practice, addressing the root cause also often reduces or prevents the likelihood of other, non-identical, incidents from occurring. This is because a mismatch at a fundamental level between the operator and work equipment, environment or work organisation has been removed. The ways in which the mismatch can be manifested in hazardous situations can be numerous. For example, personnel may be exposed to acute risks of muscular injury from attempting to apply excessive force; accidents involving crush injuries may be more likely because personnel are dealing with heavy weights; or else they may be exposed to overuse injuries, with the injury event perhaps appearing have occurred during a routine, relatively low risk manual task. Root cause analysis does not lead to treatment of the symptoms of risky manual handling (discomfort and injury, frequently longer task times) directly through training and rehabilitation strategies. Instead it is used to find and eliminate the circumstances that created the risk.

Information on recent manual handling incidents was drawn from a number of incident databases maintained by companies working in the UK offshore industry and from the HSE. The companies involved were approached by the study team with the request that they take part in the research. Initially, a trawl was made through the companies' databases to find incidents or near misses that involved manual handling. Information from these incidents was collected and analysed to find the root causes. The study team contacted individuals concerned with incidents that looked promising from the point of view of root cause analysis where the incident report did not have sufficient detail to allow the analysis to be carried out at the first pass.

Analysis of a sample of 126 recent manual handling incidents from the offshore industry indicated a variety of root causes, the majority existing at a system level. That is to say, the system or background reasons for incidents taking place have been at a management and planning level, rather than necessarily being under the control of the operators carrying out manual handling tasks. This being the case, reducing the prevalence of manual handling incidents would best be achieved by addressing system causes rather than by focussing on raising the awareness of injured personnel and their colleagues of risks, for example through re-training and re-emphasis on careful risk assessment. Effective training and risk assessment procedures are still necessary but will not reduce accident rates year by year in isolation.

The most commonly found root causes were poor workplace design, poor equipment design and the use of inappropriate equipment. Design was therefore an important issue found by the study as being at the core of many manual handling incidents. If equipment or the offshore workplace has embedded design deficiencies, almost all efforts to minimise manual handling risks will be limited to finding the best way to accommodate and work around the mismatch between the design and the operators' requirements. With an optimised design, managing manual handling risks becomes much more achievable through promoting good handling practice and management.

Inadequate risk assessment was found to be a root cause in 5% of incidents, indicating not so much that risk assessments are generally done to an acceptable level, but that a sub-standard risk assessment was not a fundamental source of risk in many incidents. The inadequate risk assessment represents an opportunity missed to identify significant risks.

The case studies presented were chosen out of the available sample because they were the strongest examples of the root cause analysis process being used to identify workable risk reduction strategies.

1 INTRODUCTION

Manual handling injuries remain a major source of lost time offshore. Targets to reduce these and other musculoskeletal injuries have been set in the Revitalising Health & Safety campaign. HSE have produced a strategic plan to meet these targets and there is a need and desire for HSE to provide further information for employers to help to avoid hazardous manual handling operations in the offshore workplace.

1.1 OBJECTIVE

Information from offshore manual handling incident reports has been analysed to establish the underlying causes and trends as well as the more obvious 'end point' causes. The objective is to contribute towards case study material aimed at preventing manual handling injuries.

1.2 DETERMINING THE ROOT CAUSE

There may be several approaches to reducing the likelihood or consequences of manual handling incidents. Some of these approaches will be straightforward to implement and others may require integration within the wider work system, with correspondingly higher demands on organisational resources. When a reportable manual handling incident occurs, there is a natural inclination in most organisations to act upon it in the most expedient way, such as by issuing further training to the injured operator. In doing this, the symptom is addressed but the underlying cause is not. For example, an investigation into a lost time injury may conclude that the operator handled too much, so he was formally reminded to ask for assistance next time. The underlying cause, that there was time pressure to finish the job and help was not to hand, can easily be ignored.

Measures that deal with the end point often attempt to equip the individual with the skills and awareness needed to avoid hazards present in their work. When awareness drops or skills are not employed properly, as happens from time to time, the latent risks cease to be adequately controlled and an accident becomes more likely.

Forty case studies have been drawn up from the offshore manual handling incident reports that were analysed. The case studies were selected because they illustrate best the link between system (that is, organisational, or other background) causes and the end point (or immediate) causes of incidents. The term root cause therefore is synonymous with the terms 'background factor(s)' and 'system cause(s)'. The case studies are included at Appendix 2.

The relationship between system causes, immediate causes and an incident is simply expressed:

System causes → Immediate causes → Incident

The system cause is the root cause of an incident as it determines the reasons why a job was being done and establishes the conditions that affected job performance. Finding the system cause requires an understanding of the critical factors that led to the incident occurring. The following example is drawn from one of the incidents gathered during the study. It shows that addressing the system cause would have removed the circumstances in which the immediate cause (the 'incident event') arose:

“The injured person (IP) was reaching for black plastic bin bags located on the top shelf in the galley on an offshore installation. To reach them she stepped on a rail below the sink. When stepping down, she twisted her ankle”.

The incident was investigated and the following conclusions drawn: “The item was placed on a shelf that was too high for the IP. Frequently used items should be placed on a lower shelf. The sink framework should not be used for reaching the top shelves - shorter personnel should use the steps provided in the dry provision area”.

There are two critical factors: the item was stored too high for a shorter operator and the sink unit rail (part of the sink framework) was not suitable for standing on. There were steps available, but for frequently performed tasks, it should be recognised that personnel are quite likely to take short cuts such as using ‘unofficial’ steps rather than expend extra effort by collecting and replacing the proper steps from another work area. Use of the sink framework was a result of having to reach for the bags, indicating that poorly located bag storage was the system cause and the unsafe act of using the framework was the immediate cause.

Storing the bags within easier reach would have taken away the reason for the IP to want to stand on the framework. A risk reduction measure that extended only to reminding personnel to use the steps would probably result in the framework being used as a step again after a period of time. To reduce similar risks in the future, it might be beneficial to find out why the bags, which were commonly used, were stored on the high shelf in the first place. Possibly the bags were put there by a taller steward who did not appreciate the inconvenience caused to shorter colleagues, or the premium waist-height storage space was crowded with other items. The bags may have been kept on the high shelf because they had ‘always been there’. In any case, suggestions for improved organisation of storage and raised awareness would be a likely outcome of the inquiry.

The example above indicates that establishing out why the risk was present and addressing the reasons for it is a more robust approach to avoiding an incident than seeking only to tackle risky behaviour, or providing equipment that should be used to reduce the risks.

1.3 POTENTIAL BIAS IN THE FINDINGS

The study was reliant on voluntary contributions from industry for the non-RIDDOR reports, which means that the reports might not necessarily be representative of the industry as a whole. A comparison between the industry reports and the compulsory RIDDOR reports was made to check whether they were significantly different. RIDDOR reports tended to involve more serious near misses or accidents whereas the incidents reported by industry also included minor manual handling incidents that were recorded in the company’s accident records system but were not reportable under RIDDOR.

Another potential source of bias in the study is the type of activities undertaken by the participating companies. Offshore industry companies might be involved in drilling, production, or supporting these activities. The study team sought to have a numerically balanced contribution from the participating companies (as described in Section 2 Approach, below). While this prevented any one company from contributing a disproportionately large number of case studies, it also had the effect of potentially raising the profile of incidents involving personnel working for companies engaged in a narrow range of activities.

Although the database is not fully representative of offshore manual handling activities, it provides a good evidence base for identifying the main causes of manual handling injuries in the offshore industry. The study indicates that root causes with their origins in design and layout appear to be most common. There is typically a limited contribution that the operator can make to reducing root causes of this type.

2 APPROACH

Manual handling incident investigation reports were obtained by contacting companies working in the oil and gas industry and requesting their participation. These companies were identified directly and via the Step Change in Safety network. The initial point of contact was through the company's Safety, Health and Environment (or equivalent) department. Depending on the format of the incident records and the preference of the participating company, the reports were sent electronically or in paper form, or a visit was made to the company to go through candidate reports there. Almost all of the reports analysed for the study were dated from 2003 to mid 2005. None was older than the year 2000. The number of reports contributed by each company was between 60 and 100. Multinational companies that took part would have been able to contribute more reports by providing those from earlier years. The study team decided that it was better to have a similar number of reports from each participating company so that the data reflected the input from offshore stakeholders in more or less equal measure.

Due to their smaller workforce and comparatively fewer incidents, smaller companies tended to provide data going back earlier than the larger companies so that equivalent numbers of reports were provided. Theoretically, all reports going back to, say, the year 2000 could have been entered into the database from all participating companies, but this would have required greater resources from the study team to process and analyse. As the aim was to provide case study material, there would have been potentially more material available than required for illustrating the benefits of root cause analysis through examples.

Not all of the manual handling incidents provided were taken forward for root cause analysis. Descriptions of incidents were sometimes too limited or ambiguous for background causes or the context of the operation to be known without contacting the originator of the report. Sufficient numbers of reports included adequate detail for analysis to avoid having to follow up the less detailed reports.

Activities involving the use of handtools or machinery were occasionally classified as 'manual handling' when the incident involved the operation of equipment. These incidents therefore would not be classified as handling under the definition provided in the Guidance on the Manual Handling Operations Regulations (1992) published by HSE in 1999: the application of human effort for a purpose other than transporting or supporting a load does not constitute a manual handling operation. The Guidance also states that an implement, tool or machine is not considered to constitute a load while in use for its intended purpose. Incidents that involved the handling of loads in conjunction with the use of equipment were included in the analysis where the manual handling aspect was integral to the incident.

The HSE provided investigation reports from the Offshore Safety Division (OSD) and RIDDOR reports that companies had submitted as part of their statutory requirement. The investigation reports were particularly useful for the analysis process because, by definition, they contained the findings of an investigation into the circumstances surrounding an incident. Around 20% of the reports used in the analysis were RIDDOR reports or investigation reports from OSD. The remaining reports were from industry.

As indicated in the briefing material to the companies participating (copy shown in Appendix 1), the object of the study was to collect information from manual handling incident reports and analyse these for underlying causes and trends. The output of the study would contribute towards case study material that would help the industry prevent manual handling injuries. Confidentiality would be preserved as information that would allow organisations, installations or individuals to be identified would not be passed to HSE or other third party.

An incident assessment template was set up in a database to hold information on the incident and background factors. The structure of the HSE Incident Investigation Brief reports was used as a prompt for the information about each report that would be held in the incident assessment template.

Other fields were included to support the study. The root cause of an incident can often be indicated by recognising the 'lessons learned' to prevent recurrence. For example, in a manual handling incident where the lesson learned was to use a ramp in future to avoid personnel having to lift barrels up a step, a background cause of the incident would appear to be poor workplace design – the transfer route of the barrel was across a walkway that did not support safe barrel handling. One would go further to ask why the barrel was being moved at all, but the principle remains.

The field 'follow up required' was used as a space in which the analyst could record the current status of the root cause analysis and other miscellaneous comments. The field 'Underlying causes' was used to record the root cause findings – it was the summary of the analysis.

'Root cause type' was used as a category field so that descriptive statistics could be run on the contents of the database. This would allow patterns to emerge, particularly showing which root causes were occurring most frequently. This would provide an indication of where efforts should be concentrated to reduce manual handling risks for the longer term.

The template included the following fields:

Table 1 Incident assessment template fields

Field name	***Description***
OIR Reference	HSE Offshore Investigation Report (OIR) number. This field used as the default for recording incident report reference numbers
Not/Inc reference	HSE database reference numbers (Notification and Incident) respectively
Incident date	Date upon which the incident occurred
Site operator	Company owning or in charge of the installation
Site manager	Name of the site manager for following up specific details
OSD team	Offshore Safety Division inspection team names for obtaining further information
Injured party	The job role of the IP
Information source	Type of incident report and issuing organisation
Incident type	E.g. pulling, pushing, glove caught in wire, impact with moving machinery

Field name	*Description*
Accident details	E.g. strained back, lacerated hand
Incident summary	Description of the incident
Root cause type	E.g. Lack of planning, poor equipment design
Lessons learned	This information can indicate the fundamental cause of the incident
Follow up required	Field for recording the current status of the incident investigation, e.g. information outstanding, person to speak to next, is the data gathering complete?
Underlying causes	Records the background to the incident once it has been established. This is a fuller description of the root cause

2.1 ROOT CAUSE ANALYSIS

In some cases there was sufficient data in the incident reports to allow the root cause to be established without the need for further enquiry. In the event that additional details were required, a proforma was developed that could be sent to the originator of the report or a person nominated by them who had an appreciation of the facts surrounding the incident. Prior to sending, the proforma was partially completed with details of the incident and specific questions and prompts on establishing the root causes or precipitating events that led to the manual handling incident.

Recipients of the proforma were asked to describe any lessons learned and underlying causes that have been addressed to prevent the incident from happening again. The recipient was invited to ask 'why' each factor prevailed to get beyond the more obvious causes. A brief worked example was included to illustrate the method of enquiry. The proforma is shown in Appendix 2. The method of enquiry shown in the proforma was that used in the research to establish the root cause(s). Table 2, below, shows the root causes and definitions used in the study. This list was also included in the proforma, though to avoid repetition it is not shown again in Appendix 2.

If further information was required, in most cases it was obtained via a telephone conversation between the researcher and company representative. The proforma was used as a prompt for both parties as it detailed the information sought and contained a list of potential root causes with explanations of the terms used. This list of root causes was used to populate the database. As more incidents were added, the list grew longer (from 13 to 27 items) to accommodate the variety of background causes of manual handling incidents. The list stabilised at around 50 incidents, after which no new root causes types were necessary. Categories that could be commonly expected such as poor maintenance, constraints on posture, or unexpectedly heavy load were considered to be insufficiently detailed for analysis. Poor maintenance, for example, could be described in more detail under headings such as inadequate equipment, poor footing, or inadequate lighting. There were sufficient numbers of incidents that fell into these more specific categories for them to be included in their own right in the analysis. Not all incidents involving, for example, inadequate equipment would of course be due to inadequate maintenance, simply because there are so many conditions that can combine to create a background cause.

The list of root cause types was kept short for several reasons:

- the study required individuals and organisations to volunteer their time and resources to provide incident data and, where required, follow-up information. Brevity was felt to be important to minimise the resources required of the participants and avoid opportunities for ambiguity in the definitions of background causes
- the aim of the study was to gather information with a view to producing case studies for industry guidance. Having more root cause categories and subcategories than there were case studies would not allow comparisons to be made easily and may appear to reduce the generic application of the case studies. Details of the underlying causes specific to each case study would be made in each case study report, so the information would not be 'lost'
- numerical analysis would be generally limited to counts and other descriptive statistics because of the nature of the data. Again, having a surfeit of root cause types would reduce the opportunity to observe patterns and trends in the data because the counts in each category would be low

Table 2 Root causes (background factors) and descriptions used in the analysis

Background factors	***Definition / explanation***
No risk assessment	Risks not formally considered, safe methods of working not planned
Inadequate risk assessment	Three common types: • Risk assessment is generic but not sufficiently relevant to the task at hand • The risk involved in the task was classified as low when it should have been higher • The task was identified correctly but the remedial measure was ineffective or unworkable or not implemented
Inappropriate equipment	Operator obliged to compensate for suboptimal tools being used - can increase risk of accident or injury. Inappropriate equipment may apply if maintenance has not been carried out correctly
Poor handling technique	E.g. load held away from the body, poor posture held for a long time

Inexperience	Operator more likely to use poor handling technique, fail to make use of lifting equipment and not communicate / work with others effectively. Inexperience is not knowing how to do something Injury because of an unexpectedly heavy load might be due to inexperience of the task and equipment used
Lack of training	Similar to inexperience, except that addressing this root cause requires training while experience is developed on the job
Lack of risk perception	Thinking the job is less risky than it actually is encourages personnel to drop their guard against danger and take on more than is advisable
Avoidable task not avoided	Was the handling necessary at all? Could an intervention ‘upstream’ have removed or changed the task?
Lack of lifting aids	Lifting aids out of operation, located elsewhere, in short supply, or not organised in time. Determining ‘why’ there was a lack often pinpoints incident root causes
Inadequate / poorly located storage facilities	Increases handling distance and potential for awkward manoeuvring over the route
Poor / missing signage	Could this have led to a mistaken assumption?
Inadequate lighting	Increased risk of slips, trips and falls. Operators not able to judge distance or the features of objects well Inadequate lighting may be due to poor maintenance
Inadequate lines of sight (e.g. to work areas / instruments)	Awkward or constrained postures are more likely when visual obstruction must be overcome

Lack of planning	Hasty assumptions made, or important issues were not thought about such as the skill or training of the operators asked to do the job; the influence of factors such as the weather; or the demands of the task were in some way mismatched in with the abilities or expectations of the operator
Time pressure	Rushing a job is more likely to lead to accidents or errors
Poor footing	Unstable or slippery surface leading to increased risk of falling. Is often due to inadequate maintenance of an area
Lapse in attention	Loss of mental focus on the task
Communication failure	Members of a team failed to communicate or instructions / information were not passed to relevant personnel from management
Rare task / task element	Tasks that are performed rarely are more likely to be performed incorrectly, especially if they have complex elements
Lack of knowledge	Operator unaware of a hazard or aspect of task performance. Is distinguished from Inexperience because the way to reduce a lack of knowledge is usually through training and a lack of experience takes time on the job
Insufficient supervision	Often in partnership with inexperience, poor supervision can lead to mistakes being unnoticed
Poor workplace design	E.g. cramped spaces, equipment or hand holds difficult to reach, long carry distances
Procedural failure	Poorly conceived or out of date procedures. Does not relate in this case to failure to follow procedure Inadequate procedures can give rise to inappropriate perception of risk Poor maintenance might be a result of a deficiency in the procedures that apply
Poor equipment design	E.g. poor coupling for the hands, bulky item, unstable or difficult to move

Inclement weather	Weather introduces hazards such as high winds, ice, water underfoot. Inclement weather can only be described as a root cause if the job had to be performed irrespective of he weather conditions

Incidents could have more than one root cause. Poor workplace design and lack of risk perception, for example, can have occurred in the same incident. It could be argued that a lack of risk perception would not matter if the workplace design had been made free of hazards, indicating that poor workplace design was the fundamental problem. Some risks cannot be practicably designed out, however. It is therefore feasible that the design of the workplace could have been improved and at the same time the individual should have appreciated that the job may have immutable hazardous aspects (such as vessel motion) that required a degree of vigilance and safety awareness.

For root cause analysis to be meaningful, the causes should all be actionable by management. While 'inclement weather' is not avoidable, there may be opportunities for mitigation such as rescheduling of tasks or avoidance of weather effects by weather-shielding built into the design. It is appreciated that the root cause 'poor workplace design' may be appropriate in several instances without there being much opportunity to change the design. For example, skidding routes[1] are determined by the location of equipment and the structure to which the equipment is attached. The costs of altering the structure to support a rearrangement of equipment may be impractical from a costs point of view. Lessons can be learned, however, for future installations to avoid the continuation of poor design features.

As mentioned above, all root causes should be actionable by management for the process to be meaningful. Separately to this point, it is acknowledged that senior management are ultimately responsible for the design and operation of a facility, although the detailed knowledge maybe held by third parties delegated to put the senior management's plans in action. The following table shows where control of the root causes lies, from a practical perspective.

Table 3 Root cause sources of control

Controlling group	***Root cause***	***Description***
Designer / architect	• Inadequate / poorly located storage facilities • Poor equipment design • Poor workplace design • Inclement weather • Poor lighting • Inadequate lines of sight • Poor footing	Storage facilities and workplace design should be driven by task demands and operator capabilities. The effects of weather can sometimes be mitigated by locating jobs away from exposed areas, or by providing cover through design of the facility.

[1] *Equipment is often moved on the platform by means of a skid or sledge*

Management / planner	• Inappropriate equipment • Lack of training • Avoidable task not avoided • Lack of lifting aids • Poor / missing signage • Inadequate lines of sight • Lack of planning • Time pressure • Poor footing • Rare task / task element • Lack of knowledge • Insufficient supervision • Procedural failure • Poor equipment design • No risk assessment	Good planning and management ensures that personnel are fully trained for the job they are expected to do. A supervisor may have a role in deploying suitably trained personnel, but on a day to day basis may not always have the available staff. Issues such as inadequate lines of sight, poor footing and poor or missing signage can often be addressed by prior planning of the task, which would extend to ensuring that the right tools and equipment were made available for the job. Maintaining up to date and effective procedures is a management responsibility Time pressure and the availability of sufficient supervision (where required) are also aspects of work that can be influenced by prior planning
Supervisors	• Poor handling technique • Inexperience • Lack of training • Lack of risk perception • Lack of planning • Communication failure • Time pressure • Rare task / task element • Lack of knowledge • Insufficient supervision • No risk assessment • Inadequate risk assessment	A Supervisor's role includes many of the features of a Manager/ Planner. The toolbox talk is an important time to discuss ways of managing risks on the job. Risk perception can be influenced strongly by the content of the toolbox talk and importance attached to it.

Individual	• Inappropriate equipment • Poor handling technique • Lack of risk perception • Avoidable task not avoided • Lack of planning • Communication failure • No risk assessment • Inadequate risk assessment	Issues such as inexperience and lack of training may affect people at an individual level, but the individual generally has limited control over them. Depending on job role and level of experience, individuals can have a varying degree of control over the equipment used for a job and the planning that goes into it.

Planners and Managers have control over the greatest number of root cause types shown in Table 3 above. Not all root causes necessarily have the same impact as others on overall risk. The importance of one over another depends on the prevailing circumstances, which makes it difficult to compare the importance of each group of individuals in reducing overall manual handling risks.

The root cause analysis was stopped when a critical factor was considered that, if resolved, would have automatically solved all of the critical factors 'above' it in the incident. To use again the simple example of the bags placed on a shelf that was too high for the steward, the process of finding the root cause went as follows:

Why did the IP twist her ankle? – IP was stepping on the sink unit framework and twisted ankle when stepping backwards off it.

Why did the IP step on the sink framework? – The bags were placed too high to reach easily and the portable steps that should have been used required time to retrieve (the IP was taking a short cut by not using them)

Why were the bags placed so high, given that they were a frequently used item? – Poor organisation of materials on the shelves. Good manual handling practice indicates that frequently used and heavier items should be placed on the shelves at waist height, other items on the upper and lowest shelves. Avoid using the uppermost shelf as it is difficult to reach. Personnel to be reminded to use the steps when required.

Addressing the third critical factor **-** poor organisation – would be sufficient to avoid the critical factors above of using an inappropriate step and twisting her ankle. The questions could continue with 'Why was the organisation poor?' but the level of detail reached is adequate for practical purposes.

3 ROOT CAUSE ANALYSIS FINDINGS

One hundred and twenty six incidents were recorded on the database. A greater number were reviewed but were not taken forward for analysis, for one of two reasons:

- the incident did not involve a manual handling activity under the description given in the Manual Handling at Work Regulations 2(1) '*manual handling operations' means any transporting or supporting of a load (including the lifting, putting down, pushing, pulling, carrying or moving thereof) by hand or by bodily force*. Using an implement, tool or machine for its intended purpose is not considered to be handling a load and is therefore not manual handling.
- Injuries attributed to manual handling are frequently caused by accumulated wear and tear to the musculoskeletal system. The activity being undertaken at the time that pain is felt may not be the cause of the injury. In keeping with the theme of the research reported here, the root cause of the injury may have been a history of risky manual handling tasks. The final task undertaken which led to pain may be comparatively trivial, such as bending down to pick up a toolbox weighing 5 kg. A number of manual handling incident reports received had insufficient information for a root cause to be identified – only the 'end point' was visible.

The chart overleaf shows the frequency with which each root cause was identified for the 126 incidents analysed.

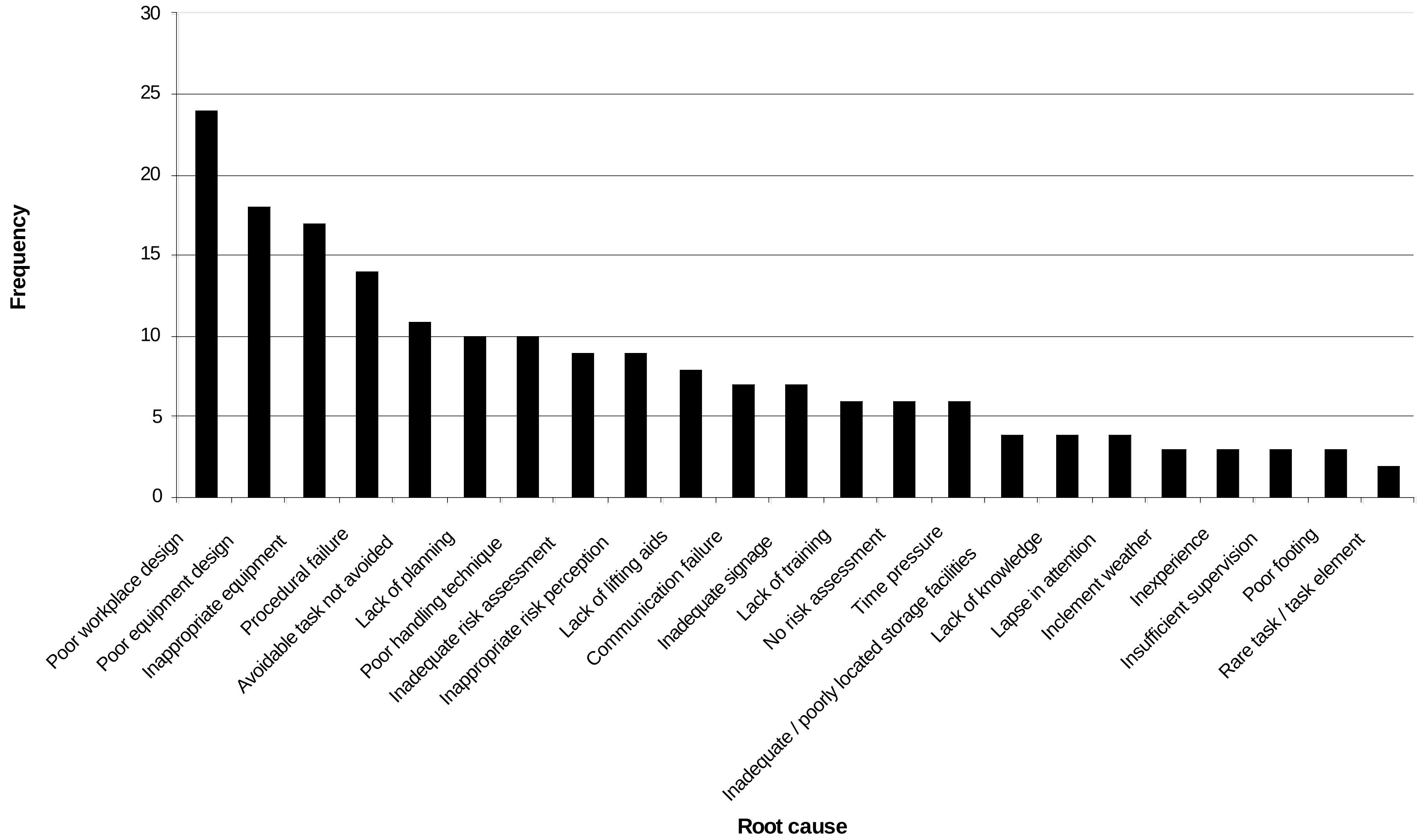

Figure 1 Root causes by frequency

The most common causes shown in Figure 1 above are linked to the workplace and equipment available:

- Poor workplace design (representing 13%)
- Poor equipment design (10%)
- Inappropriate equipment (9%)
- Procedural failure (7%), and

The next most commonly found issues are more closely linked with day to day organisation and management:

- Avoidable task not avoided (6%)
- Lack of planning (5%)
- Poor handling technique (5%)
- Inadequate risk assessment (5%)
- Inappropriate risk perception (5%)

Six of these root cause types were identified in Table 3 (Root cause sources of control) above as being under the control of Managers / Planners. Only poor workplace design, handling technique and inappropriate risk perception are largely outwith the control of management and planning personnel. Provision of training (which can influence handling technique and risk perception) is again within the remit of managers.

The following table illustrates the controlling group responsible on a day to day basis for the root causes found in the study. The root causes are listed in order of the frequency with which they occurred in the study, with the most common at the top.

Table 4 Sources of control of the most commonly found root causes

	CONTROLLING GROUP			
ROOT CAUSE	***Designer / architect***	***Management / planner***	***Supervisors***	***Individual***
Poor workplace design	✔			
Poor equipment design	✔	✔		
Inappropriate equipment		✔		✔
Procedural failure		✔		
Avoidable task not avoided		✔		✔
Lack of planning		✔	✔	✔
Poor handling technique			✔	✔

Inadequate risk assessment			✔	
Inappropriate risk perception			✔	✔
Lack of lifting aids		✔		
Communication failure			✔	✔
Poor / missing signage		✔		
Lack of training		✔	✔	
No risk assessment		✔	✔	
Time pressure		✔	✔	
Inadequate / poorly located storage facilities	✔			
Lack of knowledge		✔	✔	
Lapse in attention				
Inclement weather	✔			
Inexperience			✔	
Insufficient supervision		✔	✔	
Poor footing	✔	✔		
Rare task / task element		✔	✔	

As mentioned above, more than one root cause could be present in the same incident. In the sample analysed, 78 incidents were attributed to a single root cause; the remaining 48 had two or more root causes.

Most incidents are due to a mismatch between the operators' requirements or expectations and workplace or equipment design. If the root causes were principally to do with training or risk assessment (that is to say, linked to risk perception and avoidance), it would imply that personnel were failing to use their experience and prior training to predict and avoid manual handling risks. Where an individual has unintentionally harmed themselves or others, it follows that the task carried risks which the operator(s) had to avoid by using safe working procedures and their skill and knowledge. The root cause in fact lies with one or more risky elements of the task that the operator then has to deal with. Training and experience help only to avoid the background risks.

The findings suggest that operators are mostly being injured because of poor equipment, task or workplace design, and to a lesser extent misunderstanding the level of risk. Failure to avoid an avoidable task is similar to a lack of planning as both indicate that an overview of the work was not held that could have highlighted alternatives to risky manual handling. 'Procedural failure' is linked to planning and overview too as this root cause indicates that agreed procedures inadvertently placed operators at risk of injury.

In the sample used in the analysis, the most common root causes of manual handling incidents appear to have been in place before the job was carried out or risk assessed and before the shift's tool box talk took place. The toolbox talk, daily planning and daily performance of the job could therefore be seen as a last line of defence against risks that had not been controlled at a management level.

Lack of training as a root cause occurs in 3% of incidents analysed as part of this study but accounts for a far greater proportion in the analysis conducted by the original authors of incident reports contributed to the study, and a greater proportion still if the reports that were not carried forward (usually due to lack of detail) are included. This observation corresponds with anecdotal evidence gathered from the study team's experience, where training is the most common control measure identified in offshore manual handling risk assessments

The frequency with which issuing further training to injured operators and their colleagues is mentioned in the original incident reports is likely to be a reflection of the requirement for companies to prevent recurrence without delay. Further, redesign of equipment or workplace may be impractical given the maturity of the offshore assets and the inordinate cost implications.

Lack of training as a root cause should by definition occur rarely: training is a means of adapting the workforce to the task and environment, rather than ensuring a better ergonomic match by good design and procedures.

A percentage comparison between the 3% of incidents in this study where training deficiencies were identified as a root cause and the percentage of companies that identified training in their incident records or proforma responses cannot easily be made. This is because it is likely that 'training' in this context is probably thought of as 'lifting and handling' training in the majority of incident reports, whereas this study suggests that training in the overall management of risks may be more appropriate.

A review of the original incident reports for the 40 case studies in Appendix 3 showed that training was identified as remedial measure on six occasions (15%). Almost all of the original incident reports related to the case studies in Appendix 3 mentioned a need to raise awareness of the incident, or the risks involved via toolbox talks, 'coaching', 'experience transfer' or other similar means. Arguably these could be described as training too, but for the purposes of this comparison, only training that involved a pre-planned structured course was used as the definition. Recommended training included manual handling and risk assessment training.

3.1 CASE STUDIES

Forty case studies are presented. These are included at Appendix 3. These case studies were chosen out of the 126 incidents analysed because they featured the most logical flow between incident event, root cause and mitigation strategies.

3.2 COMMENTARY

Several hundred manual handling incident reports were examined, dated from 2000 to 2005, a small proportion of which (126 reports) were carried forward for root cause analysis. Unsafe acts were recognised as having been carried out in several of the incidents, the majority of which could be classed as mistakes, that is, the IP believed they were doing the right thing but were actually wrong. Comparatively few incidents were attributable to carelessness. The implied motivation of individuals committing unsafe acts appears to have been simply to get the job done expediently. In several incidents, personnel engaged in unsafe acts were attempting to prevent damage to machinery or other equipment, but put themselves in harm's way in the process.

The value of establishing root (or 'system') causes appears to be widely appreciated throughout the offshore industry. Several companies have produced or adopted systems that present investigating personnel with a list of root / system causes and immediate causes to use so that risks can be reduced and recurrence of incidents prevented. These root cause analysis systems are deigned to help investigate incidents of all kinds. The current study has focussed on manual handling incidents. One industry contact reported that sorting through incidents to isolate those with a manual handing constituent was enlightening. It emerged that 25% of their incidents in recent years had a manual handling contribution to them.

In pre-existing North Sea installations, retrofitting mechanical handling devices or redesigning the workplace can be an expensive undertaking. In many instances it can however be cost beneficial as work is subsequently done more efficiently and the opportunities for costly injuries and down time due to accidents are reduced. The cost of designing out a number of incidents reviewed for this study might be prohibitive, indicating that for practical purposes they cannot reasonably be designed out. Estimating the number of incidents to which this applies is difficult because the initial cost and consequences of changes to workplace design or equipment fit may be subject to a large margin of error. Thirteen percent of incidents in the study had 'poor workplace design' as a contributory root cause; 'poor equipment design' and 'inappropriate equipment' accounted for 10% each. These root causes are most likely to require significant capital outlay to fix.

3.2.1 Problems and challenges in carrying out the study

Three key risks were anticipated before the study took place. In summary, these were: lack of industry participation; insufficient incident reports to analyse; and insufficient detail in the reports. Of the three, only a lack of detail in company reports was found to be a potential problem in the study.

As far as possible, the possibility of a lack of detail was mitigated by following up the original reports to seek clarification of details. The Follow-Up Proforma shown in Appendix 2 was used to help elicit the kind of information required. In practice, the Follow-Up Proforma was best used with the researcher and the company representative using it together. This is because any potential ambiguities could be addressed immediately.

The point of contact within the participating company was usually from the health, safety and environment department (or its equivalent), but was not necessarily the originator of the report in question. They were therefore unable to provide the detail required without conducting further enquiries, or providing contact details of persons that the researcher could contact. Attempts at contacting and receiving assistance from the appropriate individuals were not always successful which meant that a small number of potential incidents (around 15) could not be progressed.

As mentioned above, the majority of incidents did not have sufficient detail to be included in the analysis. Follow-up activities were directed at those incidents that appeared to be promising from the point of view of establishing background details that would lead to the identification of root causes.

4 CONCLUSIONS

The analysis of offshore manual handling incidents indicated that the root causes tended to occur at a management level rather than with the operators more visibly involved in the incident. An error by the operator in many cases could be viewed as a removal of the last barrier that prevented the incident from occurring. In all enterprises involving human judgement and actions, a degree of error is inevitable which makes prevention of hazardous circumstances an important factor in reducing the ultimate consequences, which in the case of the present study is manual handling injuries. None of the incidents described here would have occurred if any one of the contributory root causes had been avoided. The remaining root causes would however be likely to contribute to another, different, incident in the future.

Poor design and layout of facilities was found to be the most common root cause, along with the use of inappropriate equipment: the equipment in this case tending to be the only equipment available for the job. In a mature industry such as North Sea oil and gas exploration and production, retrofitting installations to alter the design is generally unlikely to be cost beneficial. Overcoming deficiencies in design requires consideration on a case by case basis. The impact of poor design can often be reduced by applying manual handling principles to change certain aspects of the job. Good health and safety practice requires that risks be avoided where possible, or reduced. Avoiding manual handling can be achieved in many cases by planning ahead so that the need for certain jobs never arises. To be most effective, this planning may have to take place at a level in the organisation with sufficient influence to restructure planned activities and influence the actions of other departments. Using an example from the study, the provision of a float system to allow sump levels to be checked without handling the hatch plate would avoid a manual task, but is not something that could necessarily be achieved at a local level.

Where avoidance of manual handling is not practicable, reducing the risk through good manual handling practice may similarly require input from individuals or departments not immediately connected with the task at hand.

Deficiencies in agreed procedures were observed to be the next most common type of root cause. In this case, operators were carrying out the job as planned and expected, but the agreed method of working was found, subsequently to the incident, to place operators at risk of injury. Good training and planning of tasks, as well as routine review of procedures would be indicated as a means of ensuring that the established way of working continues to be the safest way.

The involvement of individuals who carry out the tasks is important in developing good practice. The detailed knowledge that comes with carrying out tasks in specific workplace environments can help to ensure that the good practice developed is practical to achieve and fits in with other work activities. Additionally, worker involvement helps to foster an ethos of shared ownership of risk management and workplace improvement.

Training, or an invocation to remind personnel of risks during toolbox talks, was indicated as a control measure in the majority of incident reports received during the course of the study. Training on its own will only be effective for those receiving it or that are made aware of its content and apply it whenever working or moving around on the platform. Changes that address the background source of the risk will have a greater permanence and will not rely so heavily on the last line of defence: the human operator.

APPENDIX 1 – BRIEFING DOCUMENT TO REQUEST INDUSTRY PARTICIPATION

HSE study into manual handling injuries offshore

The Health & Safety Executive (HSE) is seeking to gather data on offshore manual handling incidents in order to help inform their guidance for the industry. We have been commissioned by them to conduct the study; the specific objective is to collect information from manual handling incident reports and to analyse these for underlying causes and trends. The output from the study will contribute towards case study material which should help the industry prevent manual handling injuries. The study will be completed in November 2005.

Information for the case studies is being gathered via three main routes: firstly through the Stepchange network, secondly from companies directly, and finally from RIDDOR reports submitted to HSE.

All companies who are part of the Stepchange network are being invited to contribute to this study, and I'm writing to ask if you would be willing to participate. We are seeking access to the company accident records, or sickness absence database (or similar) for information that relates to manual handling injuries. We are happy to receive information from you in a format that is convenient to you e.g. printed, electronically etc, and would also be able to visit your site to collate the information if that is more convenient.

We may also want to obtain more detailed information on some incidents as to their underlying causes. These incidents will be those that have particular features that may help with developing effective prevention programmes. We have developed a proforma for gathering this information, and would be able to either post or email to you, or complete it during a telephone discussion, or during a follow-up site visit.

Please note that Hu-Tech Ergonomics will treat all information received that could identify personnel or installations, operating companies etc as confidential and such information will not be passed to the HSE. All data will be summarised in the analysis, and it will not be possible to identify individuals from the final report. We intend to acknowledge the assistance provided by participating companies, if they are willing to be named, but are happy to assure anonymity if your company would prefer it.

If you are happy to participate, I will contact you to discuss the requirements further and make arrangements for obtaining the information.

I look forward to hearing from you and hope that you will be able to assist. Please contact me if you have any queries or would like further information.

APPENDIX 2 –FOLLOW-UP PROFORMA

Manual Handling Incidents – Root Causes

Thank you for agreeing to participate in this study. This form has been designed to give a simple means for you to provide information on the root causes or precipitating events that led to a manual handling incident. Details of the incident are shown in part 1 of the form below. Part 2 has a series of prompts that are designed to help establish the root cause of the incident.

You can:

1. Fill in the form electronically on the computer and email it back to us at: **ian@hu-tech.co.uk** or:	2. Print the form off and fill it in by hand, then fax or post it back. **Fax no. 01604 604967**. FREEPOST postal address (no stamp required): ➡	**License No. NH0460** **Hu-Tech Ergonomics.** **FREEPOST** **Saxon Court, 29 Marefair,** **Northampton NN1 1BR.**

Information will be held in strictest confidence and will not be passed to HSE or any third parties except in an anonymised format.

Personal information

The information requested below is for our internal administration purposes. We will assume that the person named below will be our point of contact.

Your name ....

Job title ....

Contact telephone number ....

E-mail ....

Contact information:
If you have any questions or comments, or would like to discuss any aspect of the project please contact:

Dr Ian Randle
Ergonomics.
Tel: 01483 457 441 Fax: 01483 853 382 Mob: 07966 177 406
email: ian@hu-tech.co.uk web: www.hu-tech.co.uk

Part 1: Manual Handling Incident details

Not/Inc ID ....…………………………...

OIR/9B ………………………………….

Incident date ………………………………….

Installation or Site OIM or Manager …………………………………..

OSD Investigation Team …………………………………..

Injured Party ……………………………………...

Summary of incident / accident ……………………………………

……………………………………………………………………………………

……………………………………………………………………………………

Part 2: Identifying Root Causes

Please tick any of the factors below that applied to this incident. This will help identify the circumstances that may have made the incident more likely to take place. To avoid ambiguity, please refer to the explanatory notes in the Appendix for the meaning of the terms.

Background factors	Was this the case at the time of the incident?
	Please tick all those that apply
1. No risk assessment or inadequate risk assessment	
2. Lack of planning	
3. Time pressure	
4. Inappropriate equipment	
5. Poor handling technique	
6. Inexperience / lack of training	
7. Lack of risk perception	
8. Avoidable task not avoided	
9. Lack of lifting aids	
10. Inadequate / poorly located storage facilities	
11. Poor/missing signage	
12. Inadequate lighting	
13. Inadequate lines of sight (e.g. to work areas/instruments etc)	
14. Other. Please specify	
15. Other. Please specify	
16. Other. Please specify	

History and lessons learned

We are interested in the sequence of events that led to the incident occurring. It is often possible to trace the history of an event by looking at the lessons learned after it has happened.

For the incident identified above, please describe any lessons learned and underlying causes that have been addressed to prevent the incident from happening again. Asking 'Why' each factor prevailed is a good method of going beyond the more obvious causes. A worked example is provided below to illustrate this. The questions in square brackets show the thought process of the author.

WORKED EXAMPLE – BACK INJURY THROUGH HEAVY LIFTING IN A STORAGE AREA

1. Please identify lessons learned and underlying causes

Injury occurred due to stumbling on the edge of a pallet while carrying tong jaws.

[Why did IP stumble?] – IP walking backwards while supporting heavy load, misjudged location of pallet

[Why was IP carrying the load?] – Lack of transport equipment such as a trolley

[Why was there a lack of transporting equipment?] – The trolleys were stored at the far end of an adjoining area.

[Why were no trolleys available nearby?] – Trolleys and sack trucks had tended to be stored together in one area so that the stores personnel could see at a glance if trolleys were available. To save time, stores personnel had begun manually lifting items that were located furthest from the trolley area.

2. Do you have any sketches, drawings or photographs available of the before and after situations (or would it be possible to produce some)?

Photo of original trolley storage area could be taken. Photo could also be taken of the two additional muster points for trolleys that were established to improve accessibility.

The worked example shows a potential thread of analysis that could lead to some root causes that would otherwise not be obvious such as late requisitioning of parts. Other analysis threads could also prove useful and could be linked to training, the number of people available for the task etc.

1. Please identify lessons learned and underlying causes   **2. Do you have any sketches, drawings or photographs available of the before and after situations (or would it be possible to produce some)?**

Continue on a separate page if required. Further copies of this form overleaf.

[The proforma included another copy of the blank incident form and a glossary of terms which was the same as that shown in Table 2]

APPENDIX 3 – CASE STUDIES

The following table shows which root causes were involved in the case studies.

Table 5 Root causes and their inclusion in the case studies

ROOT CAUSE	***CASE STUDIES***
Poor workplace design	2, 13, 14, 26, 33
Poor equipment design	6, 8, 12, 18, 19, 22, 23, 25, 28, 29, 34, 40
Inappropriate equipment	4, 5, 22, 27, 30, 37
Procedural failure	5, 11, 22, 23, 35, 36, 38
Avoidable task not avoided	1, 3, 6, 21, 24, 39
Lack of planning	3, 16, 19, 20
Poor handling technique	10, 17
Inadequate risk assessment	15, 32, 39
Inappropriate risk perception	17, 21, 23, 29, 32
Lack of lifting aids	16, 26, 29
Communication failure	22, 32, 35
Poor / missing signage	6
Lack of training	6, 18
No risk assessment	16, 29
Time pressure	7, 39
Inadequate / poorly located storage facilities	9, 31
Lack of knowledge	16, 22, 26, 32
Lapse in attention	Not featured in the case studies
Inclement weather	18, 31
Inexperience	18

Insufficient supervision	16
Poor footing	Not featured in the case studies
Rare task / task element	Not featured in the case studies

1.4 CASE STUDY 1: ANKLE INJURED IN GALLEY

Area: Galley

IP role: Steward

Incident summary: IP was reaching (empty) black plastic bin bags on top shelf in the galley. She stepped onto a rail below the sink. When stepping down, IP twisted her ankle.

Root cause: Avoidable task not avoided

Comments: Item was placed on a shelf that was too high for the IP. Frequently used items (such as the bags she was reaching for) should be placed on a lower shelf nearer waist height. Personnel are more likely to bring the steps from the dry provision area to help reach an item that is used rarely, but will soon use shortcuts for routine, frequent items. Use of sink framework was not a root cause, but a result of a difficult reach.

Outcome: Frequently handled items such as waste bags should be placed on lower shelves, nearer waist height. The sink framework should not be used for reaching the top shelves - shorter personnel should use the steps provided in the dry provision area.

1.5 CASE STUDY 2: SLIP ON HYDRAULIC PIPES

Area: Cellar / substructure / cantilever

IP role: Roughneck

Incident summary: IP was preparing the cantilever for skidding. He was moving the port forward dog into its correct position for skidding forward. The counterbalance had to be moved forward, and to gain leverage on it the IP stood on the hydraulic pipes. The IP gave the counterbalance a final push past the vertical when his foot slipped on the pipes. He put both hands up to stop himself falling and his right hand went into the cantilever beam which houses the skidding dog. The dog which was moved up by the counterbalance squeezed his hand against the beam.

Root cause: Poor workplace design

Comments: IP was obliged to stand on the pipes to apply force. With the object moving away from him, the IP was likely to lose balance. In the incident, the asymmetrical loading of his bodyweight appears to have caused him to slip on the pipes. The root cause of this incident could have been avoided during the Front End Engineering Design (FEED) of the installation, where consideration of the interaction of the operators and the tasks and workplace layout is recommended (see Appendix 4).

Outcome: Two personnel to be assigned to this task in the future. A platform is to be installed on the port side (where the incident occurred). The starboard side platform is to be raised. Procedures for cantilever skidding to be amended.

1.6 CASE STUDY 3: MANUAL ROLLING OF RISERS

Area: Pipedeck

IP role: Roustabout

Incident summary: A 30ft section of drilling riser weighing 7.8 tons was being rolled from the centre to the east edge of the catwalk to allow space for a second riser section to be lowered from the drill floor. During the operation the riser section was rolled towards the IP and a pad-eye on the underside of the riser section came into contact with his left foot just behind the steel toe cap of his boot. This resulted in a bruising injury.

Root causes: Lack of planning, avoidable task not avoided

Comments: Manual rolling of risers is possible, but the uneven floor and low visibility of the pad-eyes led to the possibility of the injury occurring. More thorough planning should have identified that there were sufficient slings to allow the crane to be used and the manual handling avoided. The workparty did not lift risers with the crane because they believed that only one sling was available (in fact there were two which would have allowed the crane to be used). The riser joint pad-eyes were not easy to see which meant that the IP did not know that he may be caught underneath one.

Outcome: Riser joint pad-eyes and immediate area to be identified with high visibility paint.

1.7 CASE STUDY 4: HANDLING CABLE COIL

Area: Multi Distribution Unit

IP role: Roustabout

Incident summary: IP suffered a laceration to the small finger on his left hand whilst removing a redundant temporary cable. The IP caught his finger on a stainless steel cable identifier tag whilst wrapping the cable with insulating tape. The tape was being used to prevent the coiled cable from becoming unrolled. In order to wrap the cable with insulating tape the IP needed to remove his glove to remove tape from the roll thus leaving his hand unprotected.

Root cause: Inappropriate equipment

Comments: Personal protective equipment used by the IP was unsuitable because of the requirement to apply tape to make handling easier.

Outcome: The IP was obliged to remove his glove to use the tape. As a result an alternative method of securing coils has been identified utilising tie wraps.

1.8 CASE STUDY 5: REMOVING CABLE FROM A DRUM

Area: Utility shaft

IP role: Electrician

Incident summary: IP and others were in the process of lifting a cable drum onto jacks, to allow the cable to be removed from the drum. They found the jacks were seized and were unable to lower them to allow the work party to get under the pole they had put through the drum. They placed one end of the pole onto one jack and then three of them attempted to lift the other end onto the other jack. This end held the full weight of the cable drum. At this point the IP's left index finger was trapped between the pole and the jack.

Root cause: Inappropriate equipment, procedural failure

Comments: Jacks were not part of the platform lifting and hoisting register so were not included in the six-monthly programme of maintenance. Jacks should have been part of the inspection system.

The accident report listed the root causes as using equipment that is not fit for purpose and not following procedures regarding risk assessment and manual handling. The root cause analysis conducted for the study indicated that the jacks should have been included on the register to help ensure scheduled maintenance. If the jacks were in a serviceable condition, the incident would not have taken place. Although personnel failed to follow procedures and good practice, remedial measures aimed at reminding personnel of their obligations would not reduce the motivation to use equipment that was to hand to get a job done. As indicated in the accident report, the jacks should be included on the maintenance schedule.

Outcome: There was no risk assessment. Some members of the team were inexperienced (two had no personal safety contracts). The underlying cause, however, was failure of the jacks which indicates a failure of the maintenance process.

1.9 CASE STUDY 6: CHECKING WATER LEVEL IN SUMP

Area: Sump

IP role: Near miss – no injury sustained

Incident summary: Individual slipped causing sump plate to drop into sump opening whilst checking water levels

Root cause: Avoidable task not avoided, poor equipment design, inadequate signage, lack of training

Comments: Cover plate was likely to fall and potentially cause injury. For inspection purposes, lifting the cover could be avoided by providing another means of measuring the sump liquid level. A hatch built in to the cover would reduce the ergonomic risks. When the cover was to be opened, the risk could be reduced by fitting a hinge so that the cover would not fall away from the operator's grasp. The underlying causes were therefore that the task was not avoided, or mitigated by better design. To reduce risk further, operators should be trained in using the cover plate and a sign could be used to reinforce the training.

The accident report identified that the design should be improved to reduce the risk permanently. The potential problems with the inspection task could have been identified during the Detailed Design Phase of the design process for the facility (see Appendix 4 for human factors issues to consider during the design process).

Outcome: To avoid the task, equipment such as a float system should have been installed for measuring sump liquid level. The cover plate should have been hinged to permit visual inspection, or a hatch could have been built in to it. A sign should have been in place to state that any lifting of cover plates must be covered by permitry and a full risk assessment.

1.10 CASE STUDY 7: INCORRECT LOAD LABELLING

Area: Helideck

IP role: Near miss – no injury sustained

Incident summary: Helideck personnel removing two 20 l drums from the boot of a helicopter believed that the weights shown in the manifest were wrong. This turned out to be the case - arrangements to airfreight the drums between two fields had been made at short notice. The drums had been transported directly from stores to the helideck. Due to the imminent arrival of the flight, rather than carry one of the drums down to Admin to weigh it, an estimation of the weight for the manifest was made by feel. This turned out to be significantly less that the actual weight of the drum (5kg estimated versus 19kg actual weight).

Root cause: Time pressure

Comments: Hurrying to complete the task meant that the weight was estimated by feel, rather than taking one of the drums to Admin to be weighed. The avoidance of this step in the procedure suggests that taking items to Admin is time consuming. It might be the case that the weighing sub task could be moved to a more convenient place by providing additional weighing equipment in another location. If relocation is possible, the root cause could be said to be sub-optimal location of the weighing facility which became apparent when time was short.

The remedial action identified in the accident report was to provide coaching for the individual concerned to follow procedure at all times. The root cause analysis identified the possibility that task redesign (by making the step of weighing items more convenient) would help to ensure that personnel were less likely to contravene the procedure when time was short. Coaching would not take away the reason for wanting to estimate the weight of items when a job had to be finished quickly.

Outcome: With more time for the task, the motivation to side-step the correct procedure would have been reduced. Opportunities for providing more convenient weighing facilities should be investigated.

1.11 CASE STUDY 8: DE-MISTER ASSEMBLY MOVED

Area: Process module

IP role: Contractor

Incident summary: During process shutdown and vessel entry conditions, a team of three were re-assembling the demister unit of the GA/D first stage separator when the demister assembly moved slightly. The IP moved round to push it back into place. It tilted further and a second operator came to assist. A third operator collected a chain block to pull the apparatus back into position. IP felt shoulder and back pain the next morning.

Root cause: Poor equipment design (no securing mechanisms inside to support the grip of the support frame)

Comments: When the vessel was initially opened, the demister assembly was found to be in a collapsed state, indicating that the current securing mechanism is inadequate. A reliable securing mechanism for the demister pack within the vessel was required.

The structure is inherently top-heavy, with no pads fitted in the lower half of the ring framework; there are no physical connections between the frame and the internal walls of the vessel. It appears that although the jacking bolts are believed to have been torqued correctly, as additional weight was placed on the frame the spring washers on the jacking bolts were further compressed. This resulted in the friction grip between the frame and vessel wall being reduced to a point that the frame was able to move, allowing the complete structure to tilt. Personnel should have protected themselves rather than the equipment, but this is often easier said than done, particularly where equipment is expensive or important and personnel feel able to help. The actions of the IP contributed to his injury, but were not the root cause.

For this incident to have been avoided during the design process for the facility, it would have been necessary for safety personnel or an engineer or operator familiar with the demister assembly to consider the implications of maintaining the equipment given its top-heavy design and the potential for the jacking bolts to fail to be sufficient. Identification of the limitations of the existing design during maintenance might have been identified during the FEED phase or else during a human factors audit in the subsequent Detailed Design phase (see Appendix 4).

Outcome: Vendor procedures should reflect the requirement to check / further apply torque to the jacking bolts as the weight of the demister pads is added to the support frame. Better (because it is a design change less susceptible to human error) would be to provide securing devices on the inside of the vessel. As indicated in the accident report, the vendor is to be present in the work party during installation of this type of equipment. On this occasion, the vendor was on dayshift and no expert advice was available to the nightshift.

Each OIM to re-iterate once again at tool box talks and safety meetings to "walk away, not mitigate when things go wrong", using this incident as an example. The frame had been observed to have moved previously (days before the injurious event). Learning from this event was not properly evaluated or investigated, such that subsequent occurrences could be avoided.

1.12 CASE STUDY 9: DRUM HANDLING

Area: Onboard pipelaying vessel

IP role: Field Joint Coating Technician

Incident summary: IP was handling drum on his own (normally job done by two and transfer form storage to work area done by forklift and overhead lifting equipment). During handling, IP twisted his right knee.

Root cause: Inadequate storage facilities

Comments: Although small, there was an inevitable amount of drum handling onboard. IP carried out the job on his own when normally it is done by two persons. Even with two performing the task, there are risks of injury due to uneven distribution of the load, particularly as a result of miscommunication or stumbling by one of the team.

Outcome: As indicated in the RIDDOR report, Field Joint Coating chemicals could be stored in bulk tanks rather than drums to avoid manual handling. Improved storage of the chemicals could have been identified during the Concept or FEED stages of the design (see Appendix 4).

1.13 CASE STUDY 10: HOSE HANDLING

Area: Main deck starboard forward

IP role: Scaffolder

Incident summary: IP was steadying hose as it was being lifted by crane for positioning on a saddle. The hose whipped down its length on being raised up and pushed the IP against a handrail

Root cause: Poor handling technique

Comments: Poor handling technique - in this case occurring some time before the incident. Better hose handling would have meant that it did not need to be transferred from its location to a saddle and for the hose already on the saddle to be moved out of the way

Outcome: Hose should have been stowed properly. It was poor stowage that caused the hose to kink and flake which then required it to be placed on a saddle - this in turn required the hose that was already on the saddle to be moved to a different saddle. Appropriate stowage would have avoided the need for the task to be carried out.

1.14 CASE STUDY 11: PULLING MUD BUCKETS

Area: Decks

IP role: Roustabout

Incident summary: IP was pulling mud buckets using the cuttings chute when he slipped and hurt his coccyx.

Root cause: Procedural failure

Comments: Work organisation and design made the job hazardous. The most important of these was the issue of organisation. Due to the large quantities of mud in the area, the anti-slip material painted onto the top of the skips did not always prevent the tops of the skips from being slippery. Reorganisation of the skips would have avoided the hazardous aspect of the handling task.

Outcome: Reorganise the skips so that personnel do not have to get on top of them to move the chute from skip to skip

1.15 CASE STUDY 12: CUTTINGS HANDLING

Area: Decks

IP role: Roustabout

Incident summary: During cuttings handling, IP slipped while standing on skip lid. His foot went into the gap between the two hinges

Root cause: Poor equipment design

Comments: One type of hinge tended to stick, encouraging personnel to climb onto the skip to facilitate opening the lids. The other type of hinge (a double hinge at the lid) was fitted in this case. There was no need to stand on the skip to open this type, indicating that the IP did not know that such hinges were easier to open. Also, IP was not aware of the possibility of his foot being caught in the gap between the hinges. The tops of the skips were painted in anti-slip coating which provided an indication to personnel that climbing on top is approved. The skips were designed so that there was no need to climb on them, but with single-hinged lids being stiff to open, it may be the case that personnel would climb on all skips regardless of the hinge type to ensure easy opening.

Outcome: The risks have since been largely avoided by fitting a specially designed cuttings chute which means that personnel have no reason to climb on the skips. Identification of the problem which could have led to the solution being developed prior to installation might have occurred during the Detailed Design phase, during human factors support to the project team and contractors in the provision of equipment and guidance on workplace layout (see Appendix 4). It is unlikely that the requirement would have been identified during Concept or FEED phases (when task requirements are used to inform design requirements) because it would probably be assumed that skips could be used in the normal way, without the need for operators to climb on top.

1.16 CASE STUDY 13: LOAD HANDLING ON A LADDER

Area: Decks

IP role: Crane operator

Incident summary: IP climbing down ladder from port crane carrying bag of rags. Felt pain in shoulder

Root cause: Poor workplace design

Comments: Ladder did not provide a convenient or safe method of transiting while carrying a load. The identification of the requirement for ladder or stairs that allowed safer carrying of loads might have been identified during the FEED phase as part of the consideration of the interaction of the operators and their tasks and workplace layout.

Outcome: Ladder to be replaced with stairs. The ladder on the starboard crane has been replaced with better and safer stairs, and the company planned to install similar steps for the port crane.

1.17 CASE STUDY 14: HANDLING ON UNEVEN SURFACE

Area: Decks

IP role: Marine operator

Incident summary: While placing bags of rubbish into compactor, IP partially stepped into a tie down point and twisted his ankle

Root cause: Poor workplace design

Comments: The immediate cause could be described as lapse of attention with the root cause being the avoidable presence of the trip hazard. The tie down point was no longer required but had not been made safe. The root cause was identified in the HSE incident investigation report. This incident would probably not have been prevented during the design of the installation because there was a requirement for tie down points in the area previously. Consideration of manual handling risks when the tasks performed in the area were changed would have identified the need to re-site the task or amend the design. The workplace design no longer met requirements.

Outcome: This tie down point should have been made safe (e.g. filled with cement) to remove the tripping hazard.

1.18 CASE STUDY 15: HANDLING NEAR MOVING MACHINERY

Area: Jack up legs

IP role: Contractor

Incident summary: While manually handling a light into position, the IP placed his hand on moving winch wire, entangling his glove. The IP's attention was focussed on the position of the load being winched. The accident happened as lights were being installed at the top of the jack up legs. There was no other way to install the lights other than to use winches and manual effort.

Root cause: Job Risk Assessment (JRA) did not consider the rotating sheave / moving wire as a hazard. The operators were from a company that had a risk assessment for this job but it was not used to inform the JRA.

Comments: The work was being done near moving wire which should have been taken account of in the risk assessment. This oversight could have been corrected if the other company's risk assessment had been carried across to the risk assessment put together for the job. The immediate cause of the incident was a lapse of concentration by the IP placing his hand on the moving wire. As indicated in the HSE incident investigation report, due to the unavoidable manual handling aspect of the job, the hazard presented by the moving wire should have been the subject of reassessment when circumstances changed.

Outcome: Risk assessment process to be Change to the work because of change of location to the top of the leg should have been considered in an amendment to the new risk assessment. The other company's risk assessment should have been cross referenced to the operator company's risk assessment. The IP placed himself close to the open sheave and moving wire which placed him at risk, suggesting inappropriate perception of risk as a contributory factor.

1.19 CASE STUDY 16: HANDLING CRANE BOOM

Area: Jack up legs

IP role: Roustabout

Incident summary: As the crane boom was being lowered the IP swivelled the hook block through 90 degrees to allow the boom to come down and the block to lie squarely. The grab handles were not used by the IP for this purpose. Instead, he moved the block with his foot while holding onto the lower spacer bar. His hand was trapped by the block as it turned.

Root cause: No mechanical aids such as a cradle for receiving the block in its original orientation. Lack of knowledge. No risk assessment. Lack of planning or procedure. Insufficient supervision.

Comments: There was no risk assessment, which would have identified that the site was congested and that the hook had two grab handles built on it for the purpose of turning the block. The background system cause was that there was a flat resting surface for the block which meant that the task had to be done to ensure that the block lay properly. A cradle for the hook should have been built to avoid the task. Other influencing factors include that the IP had insufficient knowledge of the task which meant the handles were not used. There was insufficient supervision as the job was considered to be routine. There may have been time pressure because of the lowering boom which prevented the IP from being able to perceive the grab handles.

The HSE incident investigation report identified that a design change should be considered to remove the need for manual intervention. It also recommended that the spacer bar be guarded to prevent use as a hand hold and that the procedure for undertaking the task (until the handling is avoided) be circulated among other installations owned by the operator through safety meetings.

Avoidance of congestion could have been identified during the Concept stage of the design. The provision of a receiving cradle could have been identified during either the Concept stage or FEED stage of design, depending on the timing of the decision to install the type of crane used (see Appendix 4).

Outcome: Provide mechanical aid (e.g. cradle) to remove manual handling. In the meantime, ensure that correct procedure is included in risk assessment.

1.20 CASE STUDY 17: SPOOL HANDING

Area: Turret

IP role: Deck crew

Incident summary: A three man team were lifting a spool of 70-80 kg mass from the turret collar deck level. The IP was at rear of the spool and was supposed to guide it while the other two pulled it. He experienced a strained right forearm - it is believed he lifted the spool to assist but bore too much weight.

Root cause: Poor handling technique, lack of risk perception

Comments: The IP was guiding the spool and tried to help those pulling it by lifting. This led to a strained forearm. The intention was good, but the operator was poorly placed to assist.

Outcome: As identified in the accident report, the role of team members is to be reinforced at toolbox talks. Personnel encouraged to avoid risky handling.

1.21 CASE STUDY 18: INSTALLING A LINK TILT BRACKET

Area: Deck floor

IP role: Floor hand

Incident summary: The IP was being hoisted to install a link tilt bracket while carrying handtools. He held on to a nearby rail to stop himself from swaying. This caused him to swing to a horizontal position whereby the tools he was holding in his arms moved and injured his lip.

Root cause: Inexperience, lack of training, design makes use difficult, inclement weather

Comments: The IP was carrying too much when both hands would have been useful to him to stop him from swaying and tipping. A load carriage solution to secure the tools (e.g. provision of secure bags worn on the body) might have avoided the significance of inexperience and windy weather in the incident.

In the incident report, the company identified the need for a review of whether this type of lift was necessary. The root cause analysis conducted for this study did not find that the task could have been avoided. Instead, the focus was on making the handling aspect of the task safer. It is possible that the requirement to carry the tools could have been avoided, but whether this was practicable on the day of the incident is not known.

Outcome: IP may have been inexperienced and therefore allowed himself to be swung into a horizontal position while holding tools. Method for securing tools etc would have prevented the injury.

1.22 CASE STUDY 19: UNSTABLE LIFTING EQUIPMENT

Area: Deck floor

IP role: Floor hand

Incident summary: IP lifted the handle of a barrow and turned it in the direction of travel. It toppled due to the front wheels being at a 45 degree angle. The barrow was holding a 1 ton water injection diverter valve, which was half the weight for which the barrow was rated.

Root cause: Poor equipment design

Comments: Equipment was unstable when the wheels were aligned at an angle before moving off. This situation was known to several personnel and should have been reported to line management. The manufacturer did not report defect to users. Later investigation showed that the supplier had improved safety by widening the turning radius, but had not informed customers of potential problems with the older model. The root cause was poor equipment design, rather than failure to pass information on.

It is possible that a human factors audit or user trial would have identified the problem of instability of the trolleys. This would have taken place during Detailed Design (see Appendix 4).

Outcome: Information on the risk from equipment use to be promulgated better, as several personnel knew about the problem with the barrow but did not report it. A procedure needs to be put in place or publicised better so that use of equipment known to be hazardous is avoided before an injury occurs. As identified by the company, to fix the root cause, replacement trolleys should be provided.

1.23 CASE STUDY 20: FAILURE TO PREPARE CARRYING ROUTE

Area: Utility Building Level 1

IP role: Contractor

Incident summary: Two men were carrying a filing cabinet through two doors. The doors were not propped open and one of them self-closed onto the IP's hand as he carried the cabinet through.

Root cause: Lack of planning

Comments: Possible haste in wanting to get the job done by carrying on through the doors instead of planning the job so that the door could be propped open.

Outcome: The accident report indicated that a third person should have been on hand to help or else the door should have been propped open.

1.24 CASE STUDY 21: MOVING EQUIPMENT ON VESSEL DECK

Area: Deployment area for Remotely Operated Towed Vehicle (ROTV), onshore facility

IP role: ROTV operator

Incident summary: The ROTV was being moved from its maintenance position to the deployment position on the back deck. The sub was moved on its skids by manual force onto a pair of small ramps to access the raised timber deck. A 12 mm lip on the ramps had to be overcome by lifting the front of the ROTV. Although using good lifting technique, the IP felt a strong and sharp pain propagate from the hip and down to the left knee. The ROTV weighed 250 kg (including payload) and was 1.7 m long x 1.3 m high x 1.3 m wide. Raising it onto the ramps to then push onto the raised timber platform had been considered a routine, low risk task.

Root cause: Avoidable task not avoided; lack of risk perception.

Comments: An A frame and winch could have been used to avoid handling the ROTV from the servicing to the deployment area by hand. The task had been carried out by hand for a long time and no-one had thought to investigate ways of avoiding the manual handling aspects of the task.

The company identified that the way to prevent further injury was to change the way the task was carried out rather than simply remind personnel of the risks involved.

Provision of mechanical handling aids should occur during the Concept and FEED phases of design (see Appendix 4). It is possible that the use of an A frame to avoid manual handling would have been identified before the task was carried out for real.

Outcome: The ramps were replaced by wider ramps with a chamfered edge to avoid having to lift the ROTV over the lip of the ramps. The manual aspect of the task was avoided by changing procedure to using the A frame and winch.

1.25 CASE STUDY 22: HANDLING TUBING USING A TUGGER LINE

Area: Well site

IP role: Contractor

Incident summary: As tubing was being hoisted over the V-Door ramp, it swung to the left and trapped the IP's hand against the Sampson post. The IP was guiding the tubing manually at the time.

Root cause: Design made use difficult, inappropriate equipment, lack of knowledge, communication failure, and procedural failure.

Comments: The positioning of the tugger line and the restricted operation this caused meant that the tubing swung to the left. This would not be anticipated by someone new to the task. It had not been possible to captivate the tugger line at the monkey board level with the aim of restricting the movement of the line as a joint was being picked up. The lengths of chain and tubing joint meant that the ferrule joining the chain to the tugger line fouled any sling used to captivate the line at the monkey board level. As a result, tubing swung to the left side of the V-door (as seen from the drill floor) when being picked up. An appropriate procedure for the task would have clarified whether e.g. a tail-in rope could or should have been used.

Following an internal investigation the company recorded that the underlying cause was related to the operation of the tugger. It was acknowledged that the procedure for carrying out the task was not sufficiently clear to allow safe handling.

Procedures should be drawn up during the FEED stage of design and refined at the Detailed Design stage (see Appendix 4). A safe method of handling tubing could have been drawn up, or identification of the problem could have led to a permanent design solution that would have avoided the need to learn and adhere to procedures.

Outcome: An engineering solution should be found for guiding tubing and taking into account the length of the counterbalance chain so that tubing travels up the centre of the V-door instead of swinging to the left. Teams should ensure that individuals who may not be aware of hazards are made aware of them prior to assisting with the task. Technically, the IP should not have assisted with the task as he was not competent and had not been involved in the earlier toolbox talk. To raise awareness of potential hazards, all personnel involved in operations in a given area to attend toolbox talks even if they are not directly involved in the task being discussed. Tubing joints were light enough to be guided by hand, though a tail-in rope was used after the incident. Clarity in tail-in procedures was required.

1.26 CASE STUDY 23: PINCH POINTS ON C PLATE

Area: Drill floor

IP role: Contractor

Incident summary: The IP was installing a C plate and got his finger caught between the top of the drillpipe and the C plate. The C plate was being landed on top of the drillpipe tooljoints to support the internal wirleline cable.

Root cause: Design makes use difficult, procedural failure, lack of risk perception

Comments: Poor handle placement was the root cause. Failure to take action to remove the risk after it was identified also contributed. The risk of pinching was fairly well known and identified in the risk assessment, but because the risk was known about, measures like Time Out For Safety were not taken. The root cause was not tackled which meant that a lapse of attention on the part of the IP was all that was required for the incident to occur.

The company identified the immediate cause of the incident as being loss of concentration and recognised that the design of the handles was the principal background cause.

Outcome: The handles of the C plate will be modified to remove the problem by relocating the hand position away from the pinch points. Although manual handling will not be avoided, the principal risk of injury from this task will have been avoided. It is possible that lack of handholds would have been identified during user trials in the Detailed Design phase of the design of the installation (see Appendix 4).

1.27 CASE STUDY 24: BACK STRAIN THROUGH BARREL HANDLING

Area: Store area, laydown yard

IP role: Storeman

Incident summary: IP and another person were transferring 200 l barrels from a vertical to a horizontal position by pushing them over onto a tyre. The barrels were delivered in a vertical orientation and should be stowed horizontally. Once horizontal, the barrels were then stowed by forklift onto racks.

Root cause: Avoidable task not avoided

Comments: The normal route for procuring handling aids or effecting a change to improve safety is for operators to report the issue to line management who will then pass it on to the relevant department. In this case, senior management had decided that the cost of the system outweighed the safety benefits. It was understood that if operators used appropriate handling methods, the job should be safe to do.

This decision was revised in the light of this incident which acted as a warning that a more serious incident could occur because operators do not always handle material in the ideal manner. Also, the Chemical Storage container system reduced the risk of environmental contamination significantly. The combination of the safety near miss and the need to avoid environmental damage changed the balance of the argument in favour of buying the system.

The root cause analysis using the incident assessment template indicated that the task should be avoided, for example through mechanisation, because the barrels were too heavy to handle safely. If the barrels could be delivered in a horizontal orientation, or the drums could be stored vertically this too would have avoided the need for manual handling. Addressing the problem by installing the handling system addressed the root cause, whereas the previous method of risk reduction considered only the more obvious end-point of safe handling technique.

Outcome: A Chemical Storage container system that is relatively cheap and used in similar circumstances elsewhere should have been installed here. The system provides a bund for spillages, keeps drums away from the elements and improves housekeeping. The company decided to allow the drums to be stored in an upright position until the Chemical Storage system was procured to avoid manual handling.

Provision of a Chemical Storage container system could have been identified at the Concept or early FEED stage of design (see Appendix 4).

1.28 CASE STUDY 25: LIFTING AIR BOTTLES FROM A LIFEBOAT

Area: Lifeboat

IP role: Contractor

Incident summary: The IP was lifting a 60 l air bottle out of lifeboat with chain slings and fibre straps as improvised aids. The bottle had to be wriggled out of position which increases the force required to move it. The IP had fibre straps round his arm as he attempted to work the bottle free and felt pain and subsequent swelling.

Root cause: Design makes use (in this case, maintenance) difficult

Comments: Bottles were too heavy for manual lifting. Crew had to improvise with slings and chains. The bottles have now been replaced with smaller ones which reduces manual handling risks because of the lighter weight.

The accident report indicated that better planning and manual handling knowledge were required. The root cause analysis indicated that the design of the bottles or their stowage was the key issue to be addressed. Although the investigation recorded by the company extended only to the end-point cause (poor handling), the remedial action to replace the bottles with smaller, lighter, ones should successfully address the root cause. The logical extension of the report's findings – improve manual handling planning and technique – would not have removed the risk but tried to lessen its impact.

Identification of the difficulty of removing the bottles could have been identified at the Detailed Design phase of design, where awkward postures and data such as the weight of specific items to be handled becomes available (see Appendix 4).

Outcome: Better planning may have may have resulted in a safer and more effective method of rigging but this would not have tackled the root cause which was the heavy weight. The awkwardness of removing the bottles was related to the weight and the necessity for secure stowage.

1.29 CASE STUDY 26: REMOVING IRON FROM A REEL

Area: Drill floor

IP role: Contractor

Incident summary: Two men were removing a 2" plug valve (mass 40 kg) from inside a reel. One man was holding it and the other was unscrewing the connection. The first man lost his grip on the valve and it fell 1m onto the IP's foot.

Root cause: Lack of lifting aids, poor workplace design, lack of knowledge

Comments: The company identified that the plug valve should be attached to a safety rope to prevent it falling, and the reel to be rotated so that valve is at a more accessible height. The reel is to have a non-slip paint covering as it can be slippery. There was insufficient room to fit steps inside the reel. Root causes were not identified in the accident report, although changes to the workplace were identified which should address the root causes identified here.

A review of layout and procedures during the FEED phase of design might have identified and avoided the manual handling risks (see Appendix 4).

Outcome: A safety rope was not used to limit any fall should the plug valve be dropped. Also, the reel was not rotated so that the valve was at a suitable working height. The inside of the reel was slippery which made maintenance of balance difficult. The workplace was poorly designed, although in ways that were fixable.

1.30 CASE STUDY 27: PUSHING A TROLLEY

Area: Main deck

IP role: Service engineer

Incident summary: IP was one of six personnel pushing a trolley loaded with a Sea Water Lift Pump (weighing around 4 tonnes). The IP felt pain in his right calf as he pushed the trolley.

Root cause: Inappropriate equipment

Comments: IP was one of six personnel pushing a trolley loaded with a Sea Water Lift Pump (SWLP, weighing around 4 tonnes). The dedicated SWLP trolley was not available and an alternative type was used. There were reservations about the alternative trolley because its directional stability was poor. The IP felt pain in his right calf as he pushed the trolley. The risk assessment for the task had not included moving the loaded trolley. The IP’s posture was described as ‘less than optimal’. It is possible that identifying moving the trolley as a risky manual handling activity might have raised awareness of the IP and reduced the likelihood of the injury.

Outcome: The root cause, which was also identified in the accident report, was inappropriate equipment - a dedicated trolley was not available. The trolley used had known problems with directional instability, though they had been used without incident in the past. This trolley should have been fixed or a new trolley bought.

1.31 CASE STUDY 28: REEL HANDLING

Area: Subsea vessel

IP role: Bosun

Incident summary: IP was pulling a 100 kg reel across the deck and lifted the edge to get it over a lip on the deck. He lost his grip and the raised part of the reel dropped on his foot.

Root cause: Design makes use difficult

Comments: The lack of handling or lifting points prevented the reel from being moved by hand or machine. Despite this, the reel was reported to be moved regularly depending on the project type. It should therefore have been made moveable, or the tasks for which it was used reviewed to see if the reel could be assigned a permanent place. The reel was used to store soft rope mooring hawsers and was believed to have come from the shipyard rather than being part of the ship's fit. The IP should have waited for another seaman to help him as previously discussed, although it transpired on investigation by the company that the reel was too heavy for two to lift safely.

The accident report identified physical capability, lack of training, poor judgement, inadequate assessment and procedures as the root causes. The analysis conducted for this study found only that the design made handling difficult. Handling points would have permitted the reel to be moved with lifting equipment relatively safely and easily. The remaining issues such as training and judgement would be important but would have had less importance because the task would be generally safe to perform.

Outcome: The reel should have been modified so that it could be transported. The reel weighed 100 kg but could not be lifted mechanically because of a lack of designated lift points or handling points. The company decided that the reel will either be fixed in one position or will be modified to make it transportable.

1.32 CASE STUDY 29: CHANGING OUT CIRCUIT BREAKER

Area: Utilities area

IP role: Electrician

Incident summary: IP and colleague were fitting a circuit breaker (67 kg) back into the racking mechanism. As they lifted it from the trolley, the IP felt a pain in his back.

Root cause: Lack of lifting aids, no risk assessment, design makes use (in this case, maintenance) difficult, lack of risk perception

Comments: Not using a lifting aid meant that the circuit breaker (CB) was lifted manually off the trolley. There was no risk assessment or decision to use an engine lift as the job was normally carried out manually. There is a specific lifter for the circuit breaker available from the manufacturer. It was too large to fit into the area and was not procured. A trolley was used which was at the right height (25 mm or so lower than the rack) but this was large too: both lifters had to lean across the trolley to lift the circuit breaker. The trolley overlapped by approx

18 mm at each side. The trolley was therefore a partial solution, but required the crew to adopt bent forward postures during the lift. Space constraints in the racking area were the principal cause. The large size of the dedicated circuit breaker lifter and the trolley are also worth noting as underlying causes.

The job had been done like this before and although a comparatively rare task the method of carrying it out was routine. There was no rush – the task was part of planned maintenance. The job is now conducted using an engine lift and a strap. The engine lift had been available before but had not been used. Latterly (last two or three years) heavy lifting has become less common and riggers are usually brought in to move objects such as these, rather than electricians or other trades.

The company identified the absence of a risk assessment as a root cause. The lack of lifting aids in the vicinity together with poor design and lack of risk perception were identified through the assessment template developed for this study.

Integration of human factors during the Concept phase might have identified space constraints as a manual handling risk (see Appendix 4). Providing more space for the dedicated circuit breaker lifter would have avoided the injury and potentially made the task easier and quicker to perform.

Outcome: Lifting aids were available, but had not been used for this task. There was no risk assessment which would have identified that lifting aids were necessary. As recorded by the company, riggers should have been employed to carry out the removal and replacement of the circuit breaker.

1.33 CASE STUDY 30: HANDLING EMERGENCY GRAB BAG

Area: Accommodation area

IP role: Engineer

Incident summary: IP was returning to cabin following an emergency exercise. When he took his grab bag (6.5 kg mass) down to the drill, the IP noticed the shoulder strap was wound around the handle, and when he unwound it, found that the strap was broken and not attached to the bag. On returning to his cabin, the IP let someone coming in the opposite direction through the door and then reached across body with right hand to hold the door open. The bag was swung into the room with his left hand, creating a situation where his hands were crossed in front of his body with that motion. On doing this he felt pain in his upper back that radiated down through his legs.

Root cause: Inappropriate equipment

Comments: Inadequate procedure for maintenance and checking of equipment appears to have been the root cause. The bag was issued in a defective state and the IP contributed to the hazard by not checking that the handles of the bag were serviceable. The bags are kept in the cabins. They are issued on a personal basis to some extent: an orange bag indicates that it belongs to the bottom bunk, yellow for the top bunk. The Safety Tech has the job of periodically checking the bags and their contents (torch batteries etc). Personnel occupying the cabins also have a duty to ensure that equipment such as the grab bag is in good working order. Defects to be reported to Safety Team Leader or other safety personnel.

Inappropriate equipment was identified as a root cause using the incident assessment template developed for this study. The company recorded that the incident could have been prevented if the shoulder strap was in good condition.

Outcome: Bags should not be issued in a defective condition. The company identified an action on personnel to check grab bags for defects. Personnel should use shoulder straps leaving the hands free.

1.34 CASE STUDY 31: SECURING SHEET STEEL IN WINDY WEATHER

Area: Main deck (West)

IP role: Supervisor

Incident summary: The IP was trying to put back two sheets of steel (2 m x 1 m) that had blown out of position on the storage rack. As he was making them secure, a third dislodged in the wind and cut his hand

Root cause: Inadequate storage facilities, inclement weather.

Comments: Inadequate storage facilities and high winds combined to dislodge the sheet steel. The IP was not able to complete the task safely on his own - another person would probably have reduced the risks to a low level, but would not have addressed the root cause.

Inadequate storage was identified as a root cause through use of the incident assessment template developed for this study. The company recorded that storage of material was ‘below standard’ but considered this to be a behavioural / training issue rather than to do with the provision of storage facilities.

Outcome: Storage racks did not have adequate means of tying sheet steel down. The racks were sheltered by scaffold boards and a workshop container. The IP should have asked for help, though this would not have removed the source of the risk which was loose sheeting. The company identified the need to investigate a more permanent method of securing steel in the racks than the rope used temporarily. A human factors review of storage and securing facilities during the Detailed Design phase might have identified the potential for the sheet steel to come loose in windy conditions (see Appendix 4).

1.35 CASE STUDY 32: HANDLING MATERIAL NEAR TO FAN

Area: D3WW Internal

IP role: Scaffolder

Incident summary: IP was passing fire blanket material over to colleague when it was caught in a fan. The material was pulled out of the IP's hands rapidly. Twinge in back noticed when IP was in the process of standing down afterwards

Root cause: Lack of risk perception, communication failure, lack of knowledge, inadequate risk assessment

Comments: The task had to take place near the fans and it was decided to continue running one of them. If a barrier had been fitted to the active fan and the operators made aware that one of the fans was going to be running (and the hazards this involved), the task would have been of low risk. The company's accident report noted that further investigation was required as root causes were not yet established. The report did however indicate the remedial measures of isolating both fans or installing a barrier at the active fan.

Outcome: The live fan could have had a barrier put round it to prevent access. The operators involved were not informed of the decision to run one of the fans although the IP's colleague tested the suction of the fan when he saw that it was working. The risk assessment procedure was not followed thoroughly.

1.36 CASE STUDY 33: PIPE HANDLING IN CONFINED AREA

Area: Central Gap

IP role: Scaffolder

Incident summary: IP was passing tubes in a confined area and struck elbow on the bulkhead

Root cause: Poor workplace design - insufficient access space

Comments: Although access was reported to be limited, it would be useful to know if there were safer ways of transferring the tubes, e.g. by means of a drawstring. Was the IP obliged to adjust his working posture to the environment or where there other strategies available?

The accident report indicates that the underlying cause was lack of attention paid to toolbox talks. The root cause analysis conducted for this study indicates that restricted access was the underlying cause. This because a lack of attention paid during the safety brief would not have been as critical had the lack of space been addressed through redesign of the task.

Outcome: The remedy indicated in the accident report was to modify behaviour by ensuring that closer attention was paid to discussion of the hazards. The restricted working conditions would however have been apparent to the IP which suggests that the remedy would not significantly affect the likelihood of the incident recurring at some point in the future. It is possible that there was no other way to carry out the task which indicates that experience and alertness were the only mitigating strategies available.

A review of clearances for working during the FEED phase of design might have identified potential problems in the Central Gap area (see Appendix 4).

1.37 CASE STUDY 34: REMOVING SHOTBLAST KETTLE

Area: Main Deck

IP role: Roustabout

Incident summary: IP and one other person were dismantling a shotblast kettle. The front leg of the kettle had snagged on pipework during manual lifting and when the kettle was released, it tipped and the weight (6 cwt) was borne by the IP alone. The IP suffered muscular sprain to the lower back.

Root cause: Poor equipment design - design makes maintenance difficult

Comments: The kettle was snagged and had to be released which took one operator away from holding it. The workspace layout and possibly the design of the article made the job difficult and resulted in one operator bearing the load suddenly. The IP noted in the accident report that on small installations, where the deck crew are multi-disciplined, often a certain amount of manual handling is necessary to progress the job. While this statement is correct, risky manual handling should be avoided by redesign of the task or equipment. Scheduling-in the use of lifting aids such as the crane may have been appropriate for this task given the heavy weight of the kettle.

The accident report indicated a number of ways in which the risks could be reduced by redesign of the shotblast kettle fixings.

Outcome: Jobs should be planned so that personnel do not feel obliged to undertake risky operations rather than wait for a crane to become available. Redesign of the workplace could include making hopper stands higher to allow more space for removing the kettle. Grit sieves could be provided as an additional item rather than a fixture which would also have avoided the need to tip the kettle to remove it. If pots and sieves had a quick release snap-on fastener, the kettle could be dismantled in a modular way which would reduce the weight and size of the load.

Human factors investigation such as input to user trials during the later stages of the FEED or during Detailed Design of the installation might have indicated that there was little space around the shotblast kettle, and that manual handling of this heavy item could be risky if one operator lost balance or (as happened) a leg of the kettle became snagged. See Appendix 4.

1.38 CASE STUDY 35: HANDLING HOT SPOOL

Area: Helideck

IP role: Services co-ordinator

Incident summary: IP moving a small spool on the helideck in preparation for helicopter transfer. The spool had been welded but had not cooled and IP was burned. IP did not know that spool had recently been welded.

Root cause: Communication failure, procedural failure

Comments: The IP would not know that the spool was hot without communication with appropriate workshop staff (or communication from them in the form of a label or sign). The spool was allowed to leave the workshop while it was in a hazardous state.

The accident report identified lack of communication as the root cause. The suggestion for corrective action in the accident report is that spools should not be taken from the workshop until they are safe. The root cause analysis carried out during this study indicates that the procedure was at fault too, as the spool was allowed to leave the workshop in a hazardous state.

Outcome: IP did not know that spool would be hot. One lesson is to improve communication. Better yet, the spool should not have left the workshop till it was cool – this would have required a procedural control. If there was insufficient time to carry out the welding before the spool was needed then it should have been labelled as hot.

1.39 CASE STUDY 36: UNLOADING QUILL UNITS FROM CONTAINER

Area: Helideck

IP role: Contractor

Incident summary: IP and another person unloading quill units, hoses and spray units from a container. While unloading a full quill, the IP fell, though maintained a hold on the quill

Root cause: Procedural failure

Comments: The agreed procedure (to use two personnel) with hindsight was not sufficient to allow the quill to be moved with the lowest reasonable risks.

Outcome: The load was too heavy for two persons to lift safely. As indicated in the accident report, the quills should be emptied before loading or unloading. Also, three personnel should load and unload quills rather than two. The risk assessment should have led to the conclusion that the quills should be emptied before unloading and that three personnel would be required because of their weight.

1.40 CASE STUDY 37: UNLOADING BLOCK VALVE FROM CONTAINER

Area: Module 15 roof

IP role: Contractor

Incident summary: IP was lifting a block valve from a container to a place where the crane could reach it when he strained his back.

Root cause: Inappropriate equipment

Comments: Heavy items like the block valve (estimated mass 1.5 cwt) are lifted into the containers by forklift truck but must be unloaded manually offshore so that they can then be reached by a crane. Unless it is possible to fit a mechanical device offshore that would assist in unloading the containers, the possibility of transporting heavy items in skips should be considered. The underlying cause is that heavy items are delivered in a manner that makes risky manual handling unavoidable.

The problem of items being loaded by forklift into a container but having to be unloaded by hand was described in the accident report as ‘ongoing’. In this example, manual handling training and employment of good practice are of limited use in reducing risks – the source of the problem is the method of delivery of heavier material.

Outcome: Heavy items should be delivered in skips so that crane access is possible. Alternatively, a forklift or similar device should be installed offshore so that items can be moved with powered assistance.

It is possible that a requirement for provision of a mechanical aid for moving heavy items out of crates could have been identified at the Concept or FEED stages of design. Alternatively, the human factors analysis process could have identified the constraints imposed by using crates for heavier items and procedures been established to have such items delivered in skips (see Appendix 4).

1.41 CASE STUDY 38: PREPARING TO TRANSPORT A HEAVY PUMP

Area: Landing area

IP role: Rigger

Incident summary: A three ton MOL pump was secured to a trolley for moving. The base of the transporting box under the pump impeded the trolley pulling handle so the decision was made to saw the overhang off. When the IP's colleague moved the trolley forward slightly to assist, the pump tipped forward and struck IP on right shoulder. The saddles supporting the pump had not been secured. The saddles had not been secured when the pump was sent offshore but the receiving party had not noticed

Root cause: Procedural failure

Comments: The saddles were not tied in and there was no procedure whereby the saddles (and other supports) would be checked by the issuers or receivers of the equipment.

The corrective action identified by the company was for personnel to ensure that supports have been tied in. This remedy would work most of the time but would be prone to lapses by personnel unless formalised with, for example, a sign off procedure. The variety of equipment and supplies received offshore indicates that it is probably impractical to predict every eventuality in detail. Certain circumstances, such as when equipment is supported on another structure, or separate struts, could however be included in a reminder checklist. The root cause, however, was that the equipment to be handled was unstable, but in a way that was not obvious to the handlers. The focus of attention in avoiding similar incidents should be in tackling the unstable nature of the load before it is despatched.

Outcome: Personnel receiving equipment should ensure that supports have been tied in place. To remove the risk at source, there should be a check when the item was packaged to ensure that the supports were secure.

1.42 CASE STUDY 39: UNLOADING TOOLS FROM A HELICOPTER

Area: Helideck

IP role: Rigger

Incident summary: IP lifted six coil tubing tools (weighing between 45 - 60 kg, each 6 to 9 feet long) out of a helicopter. To remove the tools they needed to be lifted over some of the seats and turned. Due to restricted space in the helicopter, there was only room for one person to manoeuvre the tools. There was no room to use the heli-loader because of the position of the tools between the seats. IP strained his back while manoeuvring the tools.

Root cause: Time pressure, avoidable tasks not avoided, inadequate risk assessment

Comments: The helicopter operator did not remove the seats to make the lifting out of material safe. Subsequently, the platform personnel did not remove the seats due to perceived time pressure combined with a lack of knowledge about how to dismantle the seats.

The accident report identified that a Time Out for Safety should have taken place when it was discovered that the seats were still in place.

Outcome: The seats should have been removed and the floor cleared to manoeuvre the tools. This should have been done before they were delivered. As this was not done, the seats should have been removed on the platform before unloading. The accident report identified that personnel may require training in how to remove helicopter seats. A Time Out for Safety should take place when the risks need to be re-assessed.

The helicopter operator has been made aware of requirement to remove passenger seats when transporting this size (specifically, length) and weight of material by helicopter.

1.43 CASE STUDY 40: LIFTING SMALL PORTABLE LIGHT FITTING

Area: Pumproom

IP role: Blaster / sprayer

Incident summary: Whilst moving a portable light unit, the IP trapped his finger between the light fitting and the base bracket on the portable lighting unit. The adjustable lens fitting was free to swing around its pivotal fittings because the securing bolts were loose.

Root cause: Poor equipment design.

Comments: The securing bolts on adjustable lens fitting were loose. There was no designated lifting point or carry handle on the portable lighting.

The action needed to prevent recurrence is listed in the accident report as a requirement for counselling of the IP in the need to be more aware and vigilant when manual handling practices are adopted. While it is likely that the incident will not occur again to the IP, this action alone would not alter the likelihood of the incident occurring again on the platform, unless other personnel were party to the details of the incident and subsequent counselling.

A root cause analysis performed by the company and recorded on the accident form shows two root causes: that the light was not supplied with a dedicated lifting point, and improper manual handling due to lack of knowledge (specifically – manual handling skills). Lack of skill and, perhaps crucially, awareness, would make an incident more likely. Fixing the problem by providing dedicated and obvious lifting points would be the most effective remedy as it would reduce the importance of lack of skill / awareness considerably.

Outcome: Maintenance / proactive safety practice is required to ensure securing bolts are sufficiently tight. Lifting point or handle should be put in place for heavy items that will be handled manually. Equipment should be bought with such features in place, or such features should subsequently be fitted.

APPENDIX 4 – HUMAN FACTORS ISSUES TO CONSIDER IN THE DESIGN PROCESS

This section provides an overview of human factors issues to consider during the design of offshore installations or equipment.

The emphasis of this overview is to provide advice on avoiding manual handling incidents through good workplace and equipment design. Employing a human-centred design philosophy in the development of processes and equipment with which humans will interact will however reduce exposure to other workplace risks in addition to those associated with manual handling. Integration of human factors in the design cycle is also likely to improve the fitness for purpose of the installation and reduce operating costs as a result of efficiency in design, appropriate levels of manpower and minimisation of downtime through accidents or unscheduled maintenance. A further reading list is provided at the end of the annex.

The name and description of the design phases used in this report are typical of those used in the offshore industry. It is acknowledged that there are other terms in use and different ways of delineating the design cycle, but it is assumed that the reader will be familiar with the phases described here:

- Feasibility – definition of a business need and development of objectives. No design has taken place.
- Concept – definition of the system requirements to meet the objectives. Although higher level planning has taken place, there is as yet no physical design.
- Front End Engineering Design (FEED) – detailed specifications are produced for manufacture in the next stage. The basic design is formed, which might include the use of prototypes.
- Detailed Design and Production – Design begun in the previous phase continues and manufacture takes place

The recommended human factors input to each stage of the design process is shown below.

Table 6 Human factors issues to consider at each stage of the design process

DESIGN PHASE	*HUMAN FACTORS ISSUE OR ACTIVITY*
Feasibility	• Nominate HFI focus within project team • Outline common or critical scenarios (e.g. pig launching, pulling out of the hole, wireline operations). Include normal, start-up and shutdown or emergency conditions as appropriate • Conduct high level task description • Conduct high level hazard identification • Produce a human factors integration plan (HFIP) which identifies human factors activities needed throughout the project lifecycle • It might be appropriate to draw up a description of proposed operators describing expected training and skill level, likely age and experience to help ensure that the design will match the operators • Undertake or commission a human factors engineer to support integration of human factors into the mainstream of development
Concept	• Update HFIP and record human factors issues and details of human factors meetings and decisions • Refine scenarios and provide more detail to the task analysis. Key project team members such as project manager, process engineer, operations and maintenance personnel can provide information on work systems and tasks where significant manual handling is likely to occur. Comparison with similar existing installations can help to identify areas where workplace design could avoid or reduce manual handling. Emerging human factors issues should be integrated into the design development process so that any trade off decisions can be made by the project team regarding workplace design and outfitting. Human factors work at this stage should concentrate on the most significant human-related risks. Where risks cannot be dealt with at this stage in the design, they should be recorded in the HFIP for consideration later. Depending on the maturity of the design, features such as mechanical handling aids can be designed-in at this stage.

FEED	• Update HFIP and record human factors issues and details of human factors meetings and decisions • Refine scenarios and provide more detail to the task analysis • Using the available knowledge of the tasks and scenarios, consider the interaction of the operators and the tasks and workplace layout. Identify potential problems and ways of overcoming them through design, or through provision in the design for the installation of mechanical handling aids. Allocate functions to operators or equipment (including possible automation). • Human factors criteria should be drawn up for incorporation in contracts for vendors or suppliers. Person appointed as HFI focus should work with contractors to manage human factors risks. • Prototyping and Computer Aided Design (CAD) modelling of layout might be beneficial in reviewing issues such as maintenance access space, ingress and egress routes to ensure that operators can work without undue constraints on posture. • Storage facilities and workplace design should be driven by task demands and operator capabilities. Materials stored or delivered mechanically to the point of use avoid manual handling.
Detailed Design and Production	• Update HFIP and record human factors issues and details of human factors meetings and decisions. At this stage, the issues will be at a higher level of detail and might include workplace ergonomic aspects such as reach distances or lines of sight which could not be specified earlier in the design process. • Provide advice to vendors and suppliers to help ensure that awkward manual handling will be avoided. • Auditing of the design using a human factors checklist can provide assurance that the design is fit for purpose. • Prototyping carried out in the previous phase should continue, with human factors input. Human factors activities should be carried out in parallel with the project design development process. User trials being conducted for safety and operability assurance purposes can be used to test layout and design from a manual handling risks perspective.

1.1 Suggested reading:

1. *Human factors integration: Implementation in the onshore and offshore industries* 2002 HSE Research Report 001, HSE Books ISBN 0 7176 2529 X

2. *Human Factors Integration (HFI) Practical Guidance for IPT*. May 2001 Ministry of Defence Corporate Research Package TG5

3. *Well handled. Offshore manual handling solutions* 1997 HSE Books ISBN 0 7176 1385 2

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10/06

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